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THE PHILIPPINE
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VOL. 19 JULY, 1921 No. 1

THE EXPRESSION OF THE OCTET THEORY OF VALENCE IN STRUCTURAL FORMULAS [1]

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ONE PLATE

The science of organic chemistry, as we know it to-day, may be said to owe its very existence to the idea of structural formulas developed by Kekulé, Frankland, and Couper, sixty years ago. In the last two decades, however, the development of both organic and inorganic chemistry has been greatly retarded by the fact that Kekulé's simple "affinity units" do not represent with sufficient accuracy the actual forces which bind atoms together.

Recent attempts of physicists to apply the new knowledge of electrons to the fundamental problem of chemistry, namely, the nature of chemical affinity, met with only partial success, until Langmuir [2] finally showed that certain recent ideas of atomic structure, notably those of Lewis, [3] can be used to form a remarkably successful working hypothesis in both organic and inorganic chemistry. The conception of electron shells and shared electrons as presented by him gives one a definite picture which is undoubtedly very close to the actual nature of the union between atoms.

Langmuir's "octet theory of valence" is so simple and exact that it will be found of great value to chemists, from the over-curious student who asks his professor what makes the atoms stick together to the investigator who wishes to predict the

[1] Received for publication, February 28, 1921.
[2] Langmuir, I., Journ. Am. Chem. Soc. 41 (1919) 868, 1543; 42 (1920) 274.
[3] Lewis, G. N., Journ. Am. Chem. Soc. 38 (1916) 762.
180365

results of a reaction which has never been performed. The method used by Langmuir in applying the theory, however, appears to the writer to be somewhat cumbersome for general use, and to obscure, by its indirectness, some of the value of the theory. The purpose of the present article is to present a system for writing structural formulas which will be as simple and direct as possible, and at the same time represent the molecules as accurately as possible in terms of modern atomic theory. It is hoped not only to furnish by this means a simple method for practical application of the theory in its present stage of advancement but even to develop certain valence relationships which have not hitherto been clearly expressed.

While it is assumed that anyone interested in the subject is already familiar with recent developments of the octet theory in the hands of Langmuir and others, for the sake of clarity the subject will be briefly reviewed.

THE STRUCTURE OF ATOMS

NUCLEUS[4]

In the light of recent physical evidence the essential portion of any atom is a minute nucleus composed of positive units of electricity (sometimes called positive electrons) and a smaller number of negative units (sometimes called negative electrons, but usually simply electrons) very closely packed together and bound by the most powerful forces known. The positive units are all identical, each having a mass of approximately 1, expressed in atomic weight units. Similarly the (negative) electrons are all identical, but have negligible mass. Each electron in the nucleus neutralizes one positive unit, so the total outside electrical effect, called the nuclear charge, is measured by the number of positive units less the number of electrons (negative units). This difference is called the *atomic number* of the nucleus.

NEUTRAL ATOM

Except under very unusual circumstances, such as when traveling with extreme velocity, a nucleus is never found alone, because it normally attracts as many electrons as its atomic number, forming an electrically neutral atom. These electrons do not enter the nucleus but arrange themselves in nearly spherical concentric shells, which vary in number from one to seven ac-

[4] Harkins, W. D., Journ. Am. Chem. Soc. 42 (1920) 1956; Rutherford, E. E., Proc. Roy. Soc. London 97A (1920) 374–401.

cording to the number of electrons. The shells are filled in the following order: First shell, 2 electrons; second, 8; third, 8; fourth, 18; fifth, 18; sixth, 32; seventh, (32?). (See Table 1). The electrons either rotate, perhaps in ring form, or revolve in small [5] orbits, so that they are powerful electro-magnets. (See Plate 1.)

TABLE 1.—*The atoms arranged according to their electron shells.*

	Hydrogen period.	First short period.	Second short period.	First long period.	Second long period.	Rare earth period.	Uranium period.	Electrons in shell.	Vacancies in shell.
Number of shells	1	2	3	4	5	6	7		
Electrons in kernel	0	2	10	18	36	54	86		
Completed shell	2	8	8	18	18	32	(32?)		
	(* O)	(He 2)	(Ne 10)	(A 18)	(Kr 36)	(Xe 54)	(Nt 86)	0	--------
	(H 1)	Li 3	Na 11	K 19	Rb 37	Cs 55	* 87	1	--------
		Be 4	Mg 12	Ca 20	Sr 38	Ba 56	Ra 88	2	--------
		B 5	Al 13	Sc 21	Yt 39	La 57	Ac 89	3	--------
				Ti 22	Zr 40	Ce 58	Th 90	4	--------
				V 23	Cb 41	Pr 59	Ux2 91	5	--------
				Cr 24	Mo 42	Nd 60	U 92	6	--------
				Mn 25	* 43	* 61	--------	7	--------
						Sa 62	--------	8	--------
						Eu 63	--------	9	--------
						Gd 64	--------	10	--------
						Tb 65	--------	11	--------
						Ho 66	--------	12	--------
						Dy 67	--------	13	--------
						Er 68	--------	14	--------
						Tm 69	--------	15	--------
						Tm2 70	--------	16	--------
						Yb 71	--------	17	--------
						Lu 72	--------	18	--------
						Ta 73	--------	19	--------
						W 74	--------	20	--------
						* 75	--------	21	--------
				Fe 26	Ru 44	Os 76	--------	(8)22	--------
				Co 27	Rh 45	Ir 77	--------	(9)23	--------
				Ni 28	*Pd 46*	*Pt 78*	--------	(10)24	--------
				Cu 29	Ag 47	Au 79	--------	(11)25	--------
				Zn 30	Cd 48	Hg 80	--------	(12)26	--------
				Ga 31	In 49	Tl 81	--------	(13)27	--------
		C 6	Si 14	Ge 32	Sn 50	Pb 82	--------	--------	4
		N 7	P 15	As 33	Sb 51	Bi 83	--------	--------	3
		O 8	S 16	Se 34	Te 52	RaF 84	--------	--------	2
	H 1	F 9	Cl 17	Br 35	I 53	* 85	--------	--------	1
	He 2	Ne 10	A 18	Kr 36	Xe 54	Nt 86	--------	--------	0

* Not yet discovered.

[5] Concerning the size of these rings or orbits, there is much difference of opinion among physicists. They may be much smaller, relative to the shell, than represented in Plate 1, but larger orbits than these seem to be excluded by chemical evidence.

KERNEL [6]

The completed inner shells of an atom (that is, all the shells except the outermost) together with its nucleus, constitute the kernel. This is bound together by such strong electrostatic and magnetic forces that it is never disrupted in ordinary chemical reactions, but acts as an unchangeable unit except under extremely penetrating forces, such as those of X-rays.

SHELL

For brevity the outer shell is called simply the shell. Unless this is complete, as in the helium group, the neutral atom exerts forces, both magnetic and electrostatic, effective at a considerable distance. It is upon these forces that all chemical action depends.

This is, roughly, the theory of atomic structure which seems to meet with general acceptance among chemists at the present time.

CHEMICAL UNION

Two types of chemical union have been distinguished; namely, primary valence unions and secondary valence unions. The present paper deals chiefly with the primary type, which involves the main uniting forces of atoms. This has been subdivided into two kinds, which may be called *salt-forming* unions and *direct* unions.

Salt-forming unions are caused by the fact that an atom with a nearly complete shell has a strong tendency toward completing its shell, and is able to appropriate from another atom with a less complete shell one or more electrons. Both atoms thus become charged and attract each other. This type of union has often been represented as follows:

$$\overset{+}{\mathrm{Na}}\cdots\cdots\cdots\overset{-}{\mathrm{Cl}}$$

Direct unions have been a much more puzzling problem, but Lewis [7] has advanced the explanation, later developed by Langmuir, that they are brought about by the sharing of one or more pairs of electrons by two atomic shells. For such a union to take place it is necessary that both atoms have a tendency to complete their shells. Since, in such a case, neither can detach an electron from the other, they compromise by sharing 2, 4, or 6 (but not 1,

[6] Lewis, G. N., loc. cit.; cf. Bohr. N., Phil. Mag. 26 (1913) 1476; Parson, A. L., Smithsonian Misc. Coll. 65, No. 11; Milliken, R. A., Science 45 (1917) 321; Silberstein, L., Phil. Mag. 39 (1920) 46.

[7] Loc. cit.; cf. Parson's "group of fourteen," op. cit., p. 29.

3, or 5)[8] electrons, which then do duty in both shells. Thus two chlorine atoms, having incomplete shells of 7 each, can form two complete octets in which one pair of electrons is shared. This kind of union, which will be called in this paper a direct union, was represented graphically by Lewis as follows:

$$:\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{Cl}}}:\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{Cl}}}:$$

Langmuir has simplified the formulas, using a single line to represent a shared pair: Cl—Cl, HO—Cl—O, O═N—O—N═O, N═N═O, etc. He has shown that a large number of hitherto perplexing structures can be readily expressed in this way.

VALENCE

Chemists have always tried to make generalizations concerning the valence (that is, the quantitative combining power) of atoms. An inspection of the Langmuir formulas above tells one nothing of the true valence relations of the atoms. He calls the number of lines attached to any atom (that is, the number of pairs which it shares in that compound) its covalence, and has developed some valuable generalizations regarding this variable property. What have been considered the true valence relations, however, he consigns to the equation:[9]

$$e = 8n - 2p.$$

It seems to the writer that there are two different kinds of direct union not hitherto distinguished. By recognition of this difference it is possible to construct formulas of considerable graphic value, at the same time dispensing with the equation.

The proposed system is based on positive and negative valence, the maximum values of which are clearly expressed by Langmuir[10] as follows:

> Now the maximum positive valence is a definite conception—it represents the total number of available electrons in the shell * * * On the

[8] In the case of benzene and similar compounds, however, the writer believes that 3 electrons are shared.

[9] This equation expresses the fact that in a molecule the total number of outer shell electrons (e) exist in completed octets, which requires 8 electrons per octet ($8n$) less 2 for every pair shared ($-2p$). The interpretation of the letters is somewhat modified for the case of hydrogen, where the completed shell has 2 electrons, and the heavy atoms, whose completed shells have 18 or 32 instead of 8 electrons.

[10] Langmuir, I., Journ. Am. Chem. Soc. 41 (1919) 926.

other hand, the maximum negative valence represents the number of electrons which the atom must take up to reach a stable form like that of the inert gases.

Langmuir further brings out the facts, at least by inference, that the actual negative valence in any compound, if exhibited at all, is almost always the same as the maximum, but the actual positive valence is often less than the maximum, giving two or more classes of compounds of the same metal, such as the cuprous and cupric compounds.

It seems important to the writer to express graphically, when writing structural formulas, the actual positive or negative valence exhibited by each atom.

PROPOSED SYSTEM FOR WRITING STRUCTURAL FORMULAS

1. *Valence.*—Represent the maximum electronegative valence of an atom in the ordinary way:

$$\mathrm{H}-,\quad \mathrm{F}-,\quad -\mathrm{O}-,\quad -\underset{|}{\mathrm{N}}-,\quad -\overset{|}{\underset{|}{\mathrm{C}}}-,\quad -\overset{|}{\underset{/\ \backslash}{\mathrm{B}}}-.$$

Each line represents the organic chemist's "unsatisfied bond," the physical interpretation of which is *vacancy for one more electron in the shell.* The nitrogen atom, for example, needs three electrons to complete a shell of eight. The number of "unsatisfied bonds" for each electronegative atom can readily be found by consulting Table 1. Electropositive valence is on no account to be represented by "unsatisfied bonds" as it never causes direct union between atoms. It may be represented as follows:

$$\mathrm{Na^{I}},\quad \mathrm{Ca^{II}},\quad \mathrm{Al^{III}}.$$

2. *The salt-forming union.*—It is evident that an atom may fill a vacancy in its shell (satisfy a bond) by simply acquiring an electron, thus becoming a negative ion.[11] It may even create more bonds by the reverse process: F— becomes $\mathrm{F^{-}}$, —O— becomes $\mathrm{O^{--}}$, H— becomes $-\overset{+}{\mathrm{H}}-$, $-\underset{|}{\mathrm{N}}-$ becomes $-\overset{|}{\underset{|}{\mathrm{N}}}\overset{+}{-}$.

Negative ions having no unsatisfied bonds form stable saltlike compounds with metallic ions:

$$\mathrm{Na^{+}} \text{------} \mathrm{Cl^{-}},\ \mathrm{Ca^{++}} \text{======} \mathrm{O}$$

It is to be noted that while the formation of ions is due to the shell-completing forces of *one* of the atoms involved, the union

[11] For the lack of a better word, this term seems to be quite generally used for a charged atom even though it may not be mobile.

between the ions is due to electrostatic attraction. This is the *salt-forming* union, and will be represented by a dotted line between the ions.

3. *The normal direct union.*—When two atoms are held together due to the fact that the shell-completing forces of *both* atoms act on a pair of electrons which is shared between them, the union may be said to be direct. Such a union is to be represented by the usual line for a "satisfied bond" if it is *normal;* that is, if one electron of the shared pair has been supplied by each atom. In this case it is evident that each shell involved has filled one electron vacancy by the process of sharing and has thus "satisfied" one "bond."

Examples: H—H, H—O—H.

4. *The borrowing direct union.*—A direct union in which one atom supplies both electrons of the shared pair may be called a *borrowing union.* In this case the borrowing atom fills two vacancies in its shell (that is, satisfies two bonds), and the lending atom neither gains nor loses electrons. A convenient way of representing such a union, whereby —A— satisfies two bonds, and B none, is A ∞ B. The sign ∞ has here neither its mathematical nor its astronomical significance, but has considerable graphic value in representing that two "valence bonds" of A and none of B, are satisfied.

$$\text{Examples:}\quad \mathrm{H - Cl \propto O} \qquad \begin{array}{l} \mathrm{Cl} \diagdown \\ \mathrm{Cl} - \mathrm{P \propto O}\, . \\ \mathrm{Cl} \diagup \end{array}$$

5. *Double and triple bonds.*—Each symbol for a normal union, —, or for a borrowing union, ∞, represents one shared pair of electrons. If two or three pairs are shared by two atoms each part of the total union is represented by the appropriate symbol.

$$\text{Examples:}\quad \mathrm{N \infty N = O}, \quad \mathrm{H - C \equiv C - H}.$$

GRADATIONS IN THE ELECTROPOSITIVE TENDENCY

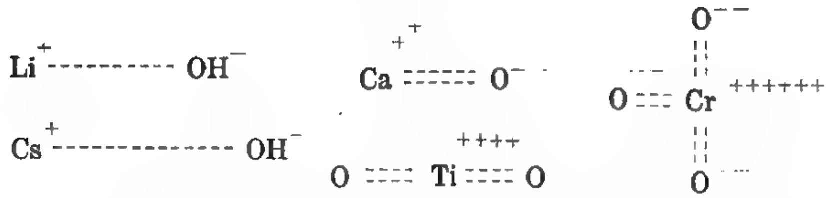
An atom which shows a tendency to become positively charged is called an electropositive atom (in the chemical sense). No atom actually repels one of its electrons to a very long distance, so this electropositive tendency is really only a comparative weakness which some atoms have in holding their electrons against any outside detaching force. In electropositive atoms the forces binding shell electrons seem to be calculable as ordinary electrostatic forces.[12] Therefore the smaller the kernel,

[12] Langmuir, I., Journ. Am. Chem. Soc. 41 (1919) 877.

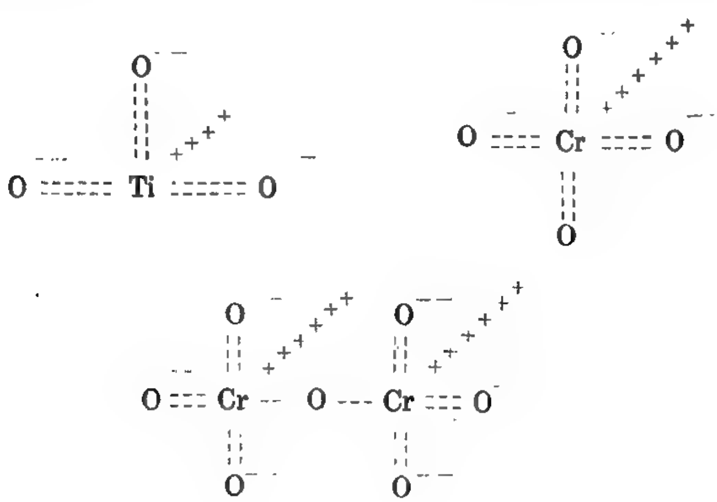
the greater the retaining force; and, in the case of two or more removable electrons, each succeeding electron is much more difficult to remove. Accordingly Cs^{I} is the most electropositive atom, and it is seldom that we find more than two or three electrons completely removed from any atom, no matter how many shell electrons it may have. Four, five, six, seven, or eight electrons may be partially removed, however, passing into the shells of other atoms, which remain closely bound to the atom in question.

Gradations in the closeness of the salt-forming union due to these differences in the electropositive tendency may be expressed roughly by varying the length of the dotted line.

EXAMPLES



Due to the closeness of union in the oxides of high valence they do not form basic hydroxides, involving rupture of the metal-oxygen union by ionization, but the central atomic kernel attracts, by its strong electrostatic field, even an excess of oxygen ions, resulting in the formation of a negatively charged aggregate as:



It is obvious that in any aggregate of an atomic kernel and $2O^{--}$, $3O^{--}$, $4O^{--}$ and in such complexes as Cr_2O_7, an octet *way* be formed around the kernel, and in many cases probably is formed. Therefore the formulas of such aggregates in which the central atom has a valence of 4, 5, 6, or 7 could be written in exactly the same manner as those of the analogous ions containing

$$
-\overset{|}{\underset{|}{C}}-,\ -\underset{|}{N}-,\ -S-,\ \text{and Cl}-,
$$

which also contain 4, 5, 6, and 7 electrons in the shell, respectively. The distinction, as it appears to the writer, is that in one class of cases all the known facts are as well explained on the basis of ordinary electrostatic attraction alone (subsequent to ion formation) as they are by assuming an effective tendency of the electrons surrounding the kernel in question toward octet formation, but that in another class of cases we have definite evidence that there is an effective tendency toward octet (or other stable shell) formation. The writer prefers to use the salt-forming symbol for the former class and the direct symbol for the latter.

GRADATIONS IN THE ELECTRONEGATIVE TENDENCY

An atom is called electronegative (in the chemical sense) when it shows a tendency to become negatively charged. As has just been intimated, the distinguishing characteristic of a negative atom is that it shows a definite tendency toward building up some stable arrangement, usually an octet, of electrons. A discussion of the forces involved is beyond the scope of this paper.[18] It is necessary only to point out that there are observed differences in the electronegative tendencies of atoms. Fluorine is the most strongly negative, and starting from this

[18] It is illogical to try to apply very closely to this case the laws of electrostatics as we know them. Latimer and Rodebush, Journ. Am. Chem. Soc. 42 (1920) 1425, treat electronegativity practically as an ordinary electrostatic phenomenon, arriving at the conclusion that "In one sense then, hydrogen is the most electronegative of all the elements." Langmuir, Journ. Am. Chem. Soc. 41 (1919) 908, approaches this problem more reasonably, concluding that "Hydrogen therefore can hardly be classed as an electronegative element." He proceeds, however, to apply (page 910) the inverse square law to the total force between the nucleus and the shell in the case of carbon and other atoms, although later (page 932) he suggests the fact that the whole existence of the shells depends on some such balance of forces as a discontinuous inverse square attraction opposed by an inverse cube repulsion.

It would seem necessary to use caution in applying any force laws to the shell electrons, especially regarding the attraction of the nucleus.

atom in Table 1, one finds a graded weakness in going either to the right or upward. Another observed fact is that the electronegative tendency of an atom varies according to the atoms combined with it, in a manner which shows that electrons in a shell are held by forces of an elastic nature, and that they shift their positions of equilibrium under the influence of outside electrostatic forces.

Due to these natural and acquired differences in electronegative powers, it is only in such symmetrical cases as Cl—Cl, $H_3C—CH_3$ that a shared pair of electrons is shared equally by two atoms. If A is more electronegative than B, in general the shared pair will be held more closely by A than by B, in such a manner that A will become negatively charged as compared to B, thus: $A^- - B^+$. Such a union has long been called a polar union, and is generally represented by an arrow indicating a partial electron transfer: $A \leftarrow B$. There is no difficulty in introducing the arrow into the proposed system in cases where it is desired to point out polarity, as $H \rightarrow Cl$, $H \rightarrow O \leftarrow H$. As the complete polarity of the salt-forming union has already been well represented by the sign $^-$----$^+$, the arrow will be used only to denote polarity in direct unions.

The distinction and relation between a borrowing union and a polar union should be clearly understood. The borrowing union sign $A \infty B$ indicates that both electrons of the shared pair belonged exclusively to the lending atom, B, *before* the union took place. The polar union sign $A \leftarrow B$ has in the past signified nothing as to the origin of the shared pair but only that after union there is an electrostatic dipole $A^- \leftarrow B^+$.

There are then two cases of polar union, depending on whether the union is normal or borrowing. From the definition it is evident that the borrowing union $A \infty B$ is essentially a polar union, because the borrowing atom —A— acquires an interest in two electrons with which it originally had no connection. Therefore if —A— was originally neutral, it becomes a negative pole. In fact, $A \infty B$ can be written $A^- - {}^+B$. Nevertheless, A shows no tendency to leave B in the form of a negative ion, and the shared pair is almost always held more closely by B than by A; so the distinct symbol $A \infty B$ should be retained, and the symbol $A \leftarrow B$ used only to represent a normal polar union; that is, one in which each atom supplies one electron of the shared pair, and in which *after* union the shared pair is more closely associated with A than with B, so that an electrostatic dipole is formed. The union $A \infty B$,

when ruptured, practically always gives the products —A— and B. The union A←B may give A— and —B, but usually $\overset{-}{A}$ and $\rangle\overset{+}{B}$.

Sometimes it is convenient for comparative purposes to express a loose, normal union by a long connecting line, and a close, strong union by a short line, as was done with salt-forming unions. A loose union is not necessarily polar:

F – F I ———— I.

All of these distinctions of gradation are entirely unnecessary in an ordinary structural formula representing merely the outstanding valence relations, but are very valuable when attention is to be called to certain comparative characteristics.

APPLICATIONS

The mode of application of the proposed system to all of the atoms will be briefly indicated. It is believed that the relations of the chemical properties of the atoms to the present theory of atomic structure will best be seen by grouping them (except H— and the group Sa—Lu) according to the horizontal lines in Table 1.

HYDROGEN

H—.

Electrons in shell = 1.
Vacancies in shell = 1.

The hydrogen atom is unique in that its bare kernel (in this case the nucleus) can acquire a complete shell simply by attaching itself to any convenient pair of electrons not already shared by two kernels. This property accounts for the peculiar mobility of the kernel, $-\overset{+}{H}-$, in molecules, which led to perplexing controversies between organic chemists until it was finally recognized and called "tautomerism." This property also distinguishes H— radically from all the other atoms having a negative valence of 1, giving it a pseudo-electropositive character. As Latimer and Rodebush [14] point out, the ionization of acids is not direct, like that of salts, but depends on a mobile (tautomeric) union of the $-\overset{+}{H}-$ with molecules of the solvent. Thus H—Cl may be considered to give $-\overset{+}{H}- + \overset{-}{Cl}$,

[14] Latimer, W. M., and Rodebush, W. H., Journ. Am. Chem. Soc. 42 (1920) 1425.

but only because the unsatisfied bonds of $-\overset{+}{H}-$ are immediately satisfied by the formation of a solvated ion, such as $H - \underset{\underset{H^{+}}{8}}{O} - H.$

This hydrated hydrogen ion may also be written:

$$\begin{array}{c} H - \overset{+}{O} - H \\ | \\ H \end{array} \qquad (2)$$

$$\left[\begin{array}{c} H - O - H \\ | \\ H \end{array}\right]^{+} \qquad (3)$$

or

$$\left[\begin{array}{c} H \rightarrow O \leftarrow H \\ \uparrow \\ H \end{array}\right]^{+} \qquad (4)$$

The advantage of formula (2) is that it shows the symmetry of the compound. It is readily seen that a borrowing bond may be considered as a normal bond preceded by the transfer of an electron. Imagine $-\underset{|}{O} + -\overset{+}{H}-$ to become by transfer $-\underset{|}{\overset{+}{O}}- + -H$, which then combine by normal union. Actually the transfer does not take place first, but at the moment of union there is a distribution of the positive charge. This fact is best expressed by formula (4), but (2) is a simpler expression of valence relations.

EXAMPLES

$$\overset{+}{Na} \text{------} \overset{-}{H}, \quad H - O - H, \quad H - Cl.$$

THE HELIUM GROUP

He^{0}, Ne^{0}, A^{0}, Kr^{0}, Xe^{0}, Nt^{0}.
Electrons in shell = 0.

These atoms have zero valence, but according to the octet theory they may possibly have the power of combining with oxygen or with $-\overset{+}{H}-$ as follows:

$Xe + -O-$ giving $Xe \propto O$, $Xe + -\overset{+}{H}-$ giving $Xe \propto \overset{+}{H}$.

If so, the combination would be very unstable, as these "inert" atoms have very weak external fields.

THE LITHIUM GROUP

$$\overset{\text{I}}{\text{Li}},\ \overset{\text{I}}{\text{Na}},\ \overset{\text{I}}{\text{K}},\ \overset{\text{I}}{\text{Rb}},\ \overset{\text{I}}{\text{Cs}}.$$

Electrons in shell = 1.

The atoms of this group have an electropositive valence of 1. Their outer shells are too incomplete for the formation of completed shells, and therefore they enter only into salt-forming unions:

$$Li^{+}\text{------}Cl^{-},\quad Li^{+}\text{------}O^{--}\text{------}Li^{+},$$

$$Li^{+}\text{------}H^{-},\quad Na^{+}\text{------}Cl^{-},\quad Cs^{+}\text{------}Cl^{-}.$$

THE BERYLLIUM GROUP

$$\overset{\text{II}}{\text{Be}},\ \overset{\text{II}}{\text{Mg}},\ \overset{\text{II}}{\text{Ca}},\ \overset{\text{II}}{\text{Sr}},\ \overset{\text{II}}{\text{Ba}},\ \overset{\text{II}}{\text{Ra}}.$$

Electrons in shell = 2.

These atoms are similar to the lithium group except that each loses 2 electrons:

$$Be^{++}\,\text{======}\,O^{--},\quad Cl^{-}\text{------}Ca^{++}\text{------}Cl^{-},$$

$$Br^{-}\text{------}Ra^{++}\text{------}Br^{-}.$$

THE BORON GROUP

$$B^{\text{III}}\ (-\overset{|}{B}-),\quad Al^{\text{III}}\ (-\overset{|}{Al}-),\quad Sc^{\text{III}},\quad Yt^{\text{III}},$$

$$La^{\text{III}},\quad Ac^{\text{III}}.$$

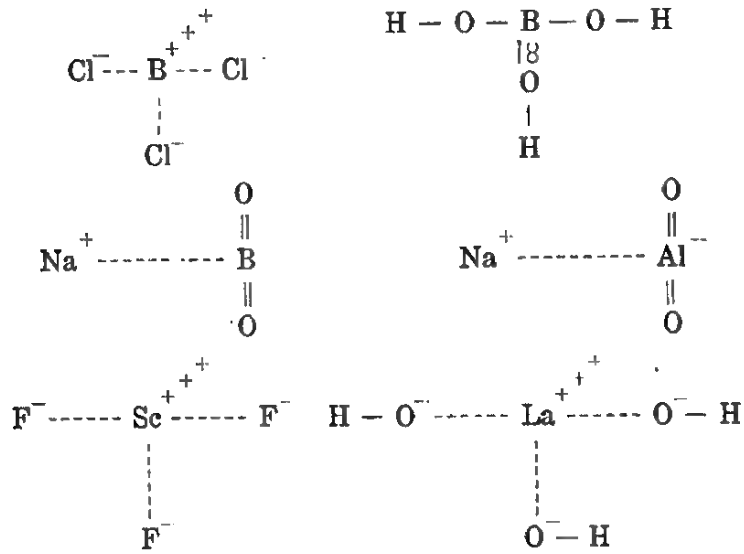
Electrons in shell = 3.

This group is predominantly electropositive. Under favorable circumstances, however, the first two members can complete their outer shells, thus exhibiting a negative valence of 5. That this property stops abruptly with Al^{III} is due to the fact that Sc^{III} would require 15 electrons, instead of 5, to complete its shell.

The compounds in which B is electropositive are not at all typical saltlike compounds. The negative ions surround the small B^{+++} kernel so completely and so closely that the external field is small and rupture of the union very difficult.[15]

[15] cf. Langmuir, ibid. p. 929.

EXAMPLES



THE REMAINING ELECTROPOSITIVE GROUPS

$Ti^{(II, III)\ IV}$, Zr^{IV}, $Ce^{(III)\ IV}$, Th^{IV}.

$V^{(II, III, IV)\ V}$, $Cb^{(II, III, IV)\ V}$, $Pr^{III\ (IV)}$, Ux_2.

$Cr^{(II, III)\ VI}$, $Mo^{(III, IV)\ VI}$, $Nd^{III\ (IV?)}$, $U^{(III, IV, V)\ VI}$.

$Mn^{II\ (III, IV, VI)\ VII}$.

$Sa^{(II)\ III}$, $Eu^{(II)\ III}$, Gd^{III}, $Tb^{III\ (IV?)}$, Ho^{III},

Dy^{III}, Er^{III}, Tm^{III}, Tm_2^{III}, Yb^{III}, Lu^{III}.

$Ta^{(II, IV)\ V}$.

$W^{(II, IV, V)\ VI}$.

$Fe^{(II)\ III\ (IV)}$, $Ru^{II, III\ (IV, VI, VII, VIII)}$, $Os^{II, III, IV, VI, VIII}$.

$Co^{II\ (III)}$, $Rh^{(II)\ III\ (IV)}$, $Ir^{II, III, IV}$.

$Ni^{II\ (III)}$, $Pd^{II, (III, IV)}$, $Pt^{II, IV\ (VI)}$.

$Cu^{I, II}$, Ag^{I}, $Au^{I, III}$.

Zn^{II}, $Cd^{(I?)\ II}$, $Hg^{I, II}$.

$Ga^{(II)\ III}$, $In^{(I, II)\ III}$, $Tl^{I, III}$.

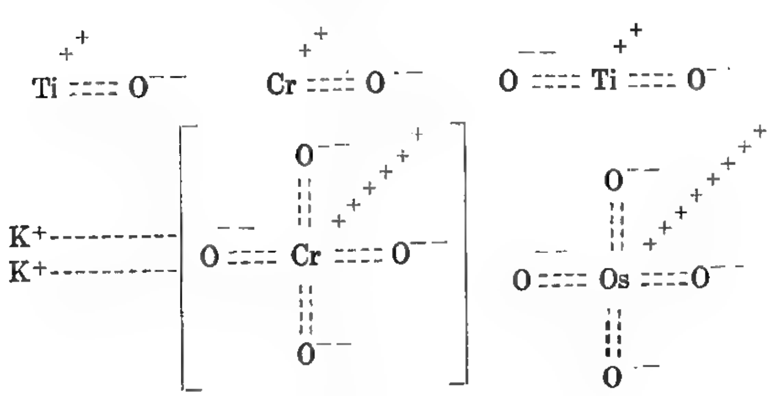
Electrons in shell = 4 to 27.

From what has been said one would expect the common valence of these atoms to be about 3, and the maximum to be 8 in Sa and all atoms below it in Table 1. The actual valences, however, have been successfully explained by Langmuir [16] on the basis of the stability of certain partly completed shells. The shells of Ni, Pd, Er, and Pt, can have a stability remotely resembling that of the inert atom shells, but only when rearranged in a form (the β form) not stable except when surrounding a kernel more highly charged than the kernels of these respective atoms. Therefore, some of the atoms somewhat below Ni, Pd, Er, and Pt in Table 1 tend to lose electrons until they have a pseudo-kernel of the form β-Ni, β-Pd, β-Er, and β-Pt. This is made possible only by the rearrangement just mentioned, and therefore does not affect any atoms above these in the table.

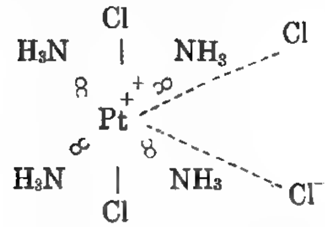
There are probably slight electronegative tendencies in some of this large number of atoms, that is, forces tending toward completion of certain stable arrangement of shell electrons. Any such forces are so weak, however, that we have no evidence of them except, perhaps, in a few compounds like Na_3ZrF_8, $[Co(NH_3)_5Cl]Cl_2$, $[Pt(NH_3)_4Cl_2]Cl_2$.

It is usual to make somewhat larger groups of the atoms, but it seems to the writer that the grouping in Table 1 shows most plainly the relations between the structure of atoms and their chemical properties. The partial relation between such groups as the chromium and sulphur groups has already been pointed out, and it is easily seen that the partial resemblance of β-Ni, β-Pd, β-Er, β-Pt to the inert atoms causes a number of partial similarities, such as those between the copper and lithium groups and the zinc and beryllium groups.

EXAMPLES



[16] Ibid. p. 876.



THE CARBON GROUP

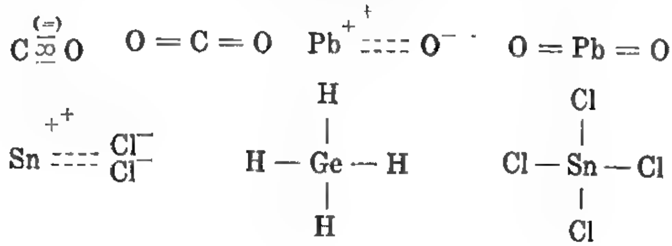
$-\overset{|}{\underset{|}{C}}-$, $-Si-$, $-\overset{|}{\underset{|}{Ge}}-$, (Ge^{II}), Sn^{II} $(-\overset{|}{\underset{|}{Sn}}-)$, $Pb^{(I)\ II\ (III)}$ $(-\overset{|}{\underset{|}{Pb}}-)$.

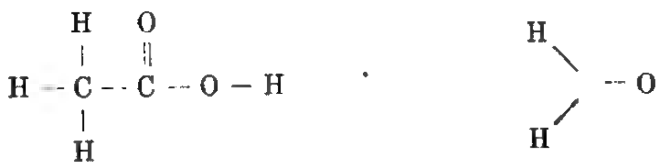
Vacancies in shell = 4.

There is unmistakable evidence that there are definitely four vacancies in the shell of each of these atoms. Sn^{II} and Pb^{II} are predominantly electropositive; but, as the relation of these atoms to the "inert group" has been established by physical evidence, each containing 4 less electrons than the corresponding inert atom, we have good reason to believe that this fact plays a large part in determining their chemical properties. This idea is substantiated by the behavior of $-\overset{|}{\underset{|}{Sn}}-$ and $-\overset{|}{\underset{|}{Pb}}-$ in organic compounds.

The ordinary carbon-hydrogen-oxygen compounds are expressed in the proposed system exactly in the same manner as is customary among organic chemists. The peculiar compound CO, however, has never been successfully explained except by Langmuir's hypothesis that the two kernels share 5 pairs of electrons, 1 pair being held rather closely by the kernels and the other 4 pairs in an octet external to both kernels. In this case the valence of each atom is increased by 2, because a stable arrangement of 10, instead of 8, shell electrons is formed.

EXAMPLES





THE NITROGEN GROUP

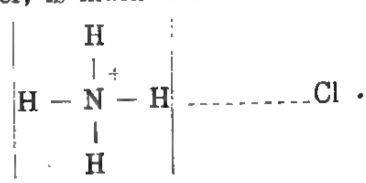
$-\overset{|}{N}-$, $-\overset{|}{P}-$, $-\overset{|}{As}-$, $-\overset{|}{Sb}-$ (Sb^{III}), $Bi^{(II)\ III}$ ($-\overset{|}{Bi}-$).

Vacancies in shell = 3.

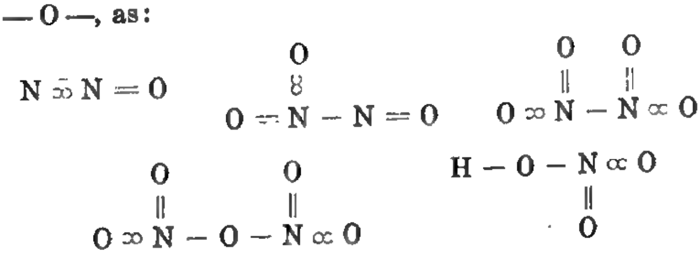
The system of structural formulas used by organic chemists has never been applied successfully to compounds containing "pentavalent" nitrogen. According to the proposed system nitrogen never shows in these compounds a valence above 3, although, as pointed out by Langmuir, the covalence is 4. The three cases where nitrogen has a peculiar valence of 5 are

$N \overset{(\equiv)}{=} N$, $N \overset{(\cdot)}{=} O$, and $-C \overset{(\equiv)}{=} N$ and are explained by Langmuir as being "isosteric" with $C \overset{(\ )}{\infty} O$.

The cases where nitrogen has been supposed to show a high valence are explained either by the borrowing union or by the formation of a positive ion. The formation of ammonium salts is strictly analogous to the reaction between H—Cl and H—O—H, described in connection with hydrogen. The ammonium ion, however, is much more stable than OH_3



In the case of nitrogen oxides and oxy-acids N has such a tendency to a covalence of 4, that it *lends* electrons, especially to —O—, as:

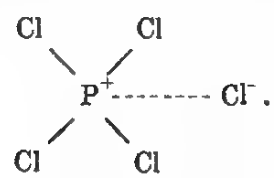


180365—2

It would not be expected, however, that — N — could borrow from a strongly negative atom as — O —, forming such a compound as N $\overline{\supset\supset}$ O $\overline{\subset\subset}$ N.

In a few compounds the heavier atoms of this group show electropositive tendencies. The salts of Bi III are good examples of how the weak forces toward completion of a shell may be entirely overcome by some stronger shell, and electrons lost, rather than gained, by the weakly negative atom. It has often been considered that in the formation of pentahalides the atoms of this group show a positive valence of 5. A comparison with vanadium, which of all the positive atoms has the greatest similarity to the trivalent negative atoms, is of interest. The most evident difference is that the halides and oxyhalides of this group indicate valences of 3 and 5, but never 4. Vanadium, as would be expected from the consideration of electrostatic forces, shows also a valence of 4.

It is evident then, that the trihalides of this group have a stability which does not permit of the addition of one more halogen atom. When two are added they probably form a compound strictly analogous in structure to NH_4Cl in most, if not all, cases.[17] Thus, PCl_5 is tetrachlorophosphonium chloride:



THE OXYGEN GROUP

— O —, — S —, — Se —, — Te —, Ra F.

Vacancies in shell = 2.

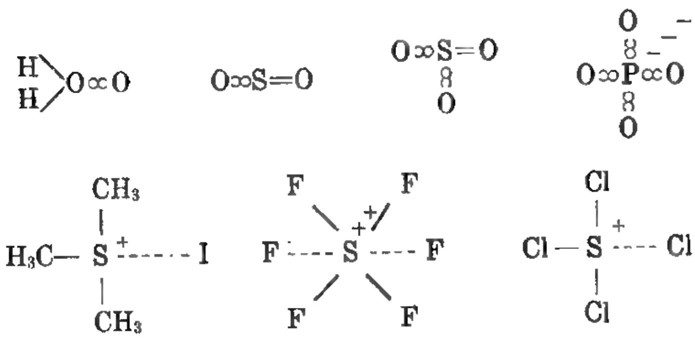
In most compounds containing borrowing unions it is found that either —O—, or —S— is the borrowing atom. This is not surprising, as of all the atoms capable of acting in this way these two are the most electronegative. It is the borrowing union which explains the fact that the number of oxygen atoms which can attach themselves to a negative atom depends more on the size of that atom than on its valence. Thus we have ClO_4^-, SO_4^{--}, PO_4^{---}, SiO_4^{----}, but NO_3^-, and CO_3^{--}.

The sulphonium and oxonium salts, so familiar to organic chemists, are assigned formulas analogous to those of ammonium salts.

[17] cf. Langmuir, ibid, p. 919.

In comparing the halides of this group with those of Cr, Mo, W, and U, we find even stronger indications of definite shell-completing action than were noted in the preceding group. There seems to be no other explanation for the avoidance by S, Se, and Te of the apparent valences 3 and 5 except that they retain always their negative valence of 2, attracting halogen atoms beyond this amount only in pairs, and in the same way that NH_3 combines with HCl.

EXAMPLES

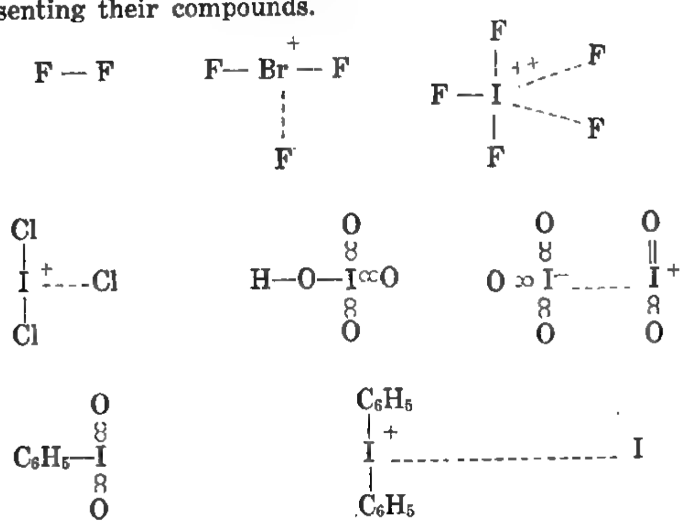


THE HALOGENS

F—, Cl—, Br—, I—.

Vacancies in shell = 1.

As these are typical negative atoms, there is no difficulty in representing their compounds.



CONCLUSION

Anyone who has found it necessary to use as guides in experimental work such valuable but hazy and incomplete valence theories as those of Werner, Thiele, Friend, and Nef will welcome Langmuir's octet theory of valence as the true "key to the situation." It is hoped that the proposed system of structural formulas will be found valuable not only as a method for representing the primary valence relations of atoms in molecules but as a better basis than has been available in the past for the study of polarity, secondary valence, reactivity, selective absorption, and other phenomena depending on the shell electrons. It has enabled the writer to see certain perplexing reactions in a new light, and has led to the formulation of a theory of reaction mechanism of the direct union, which will be published in the near future.

SUMMARY

1. A system for writing structural formulas has been devised, based on the octet theory of valence as presented by Langmuir.

2. The new feature of the system is a distinction between "normal" and "borrowing" unions which enables the actual valence relations of the atoms to be represented in the formulas.

3. The borrowing union, $A \infty B$, is unique in that it is polar in the direction $A \; {}^{-}\!\!-^{+} \; B$ although the shared pair is held more closely by B.

4. The mode of application of the system to all of the known elements has been indicated.

5. The system in itself represents only the primary valence relations of the atoms, but can easily be adapted to the study of other phenomena depending on the valence electrons.

ILLUSTRATION

PLATE 1. MODELS OF THE ELECTRON SHELLS

As the exact forces (see p. 3) acting on shell electrons are not known, these models are to be considered only very rough approximations to the actual proportions and arrangements. The arrangements shown are based on the assumption that magnetic attraction is the determining force. The white rings represent electrons revolving in orbits, or in actual ring shape, in a direction clockwise to the observer, the black ones, counter-clockwise. Paper disks are placed inside to increase the visibility.

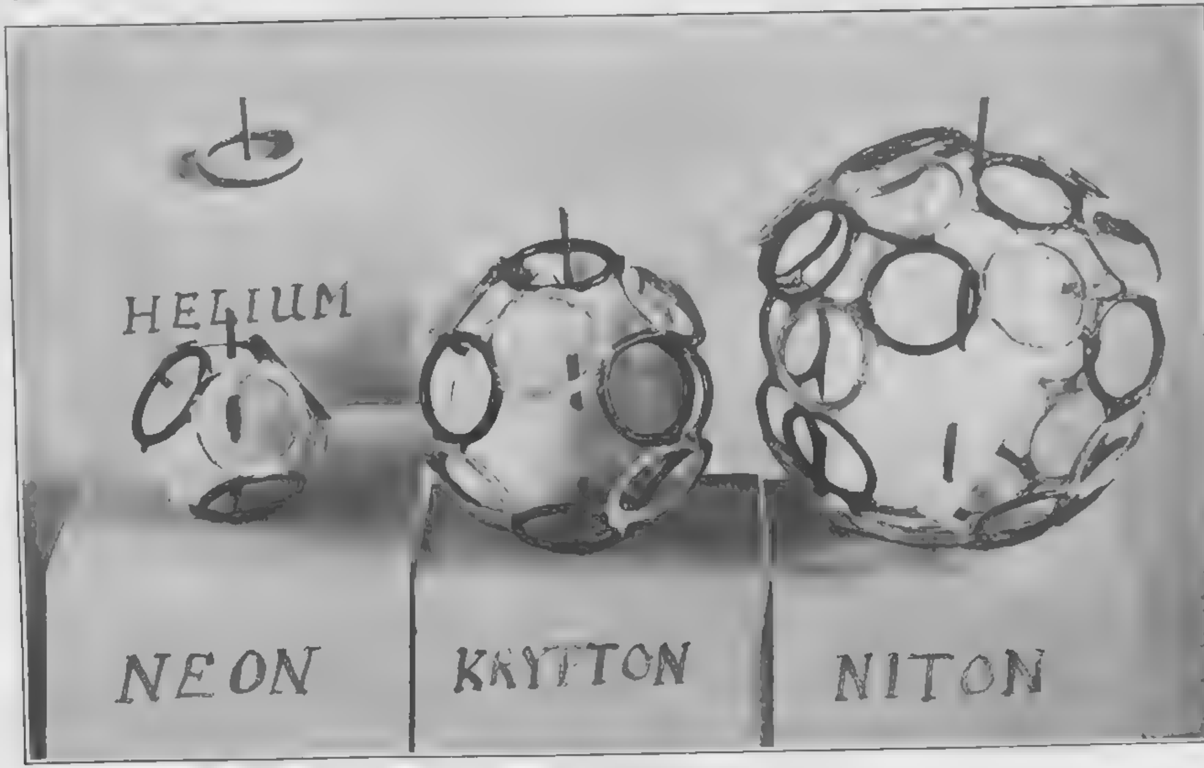


PLATE 1. MODELS OF THE ELECTRON SHELLS.

NOTES ON PHILIPPINE TERMITES, II

By S. F. Light

Professor of Zoölogy, College of Liberal Arts, University of the Philippines

SIX PLATES AND THREE TEXT FIGURES

This paper presents descriptions of six species of Philippine termites which seem to be new to science. They represent four genera (*Kalotermes, Cryptotermes, Prorhinotermes,* and *Leucotermes*) not heretofore reported from the Islands and one new genus, *Planocryptotermes.* The list of species described is as follows:

Genus *Kalotermes* Hagen sensu restricto.
1. *Kalotermes mcgregori* sp. nov.

Genus *Cryptotermes* Banks.
2. *Cryptotermes cynocephalus* sp. nov.

Genus *Planocryptotermes* gen. nov.
3. *Planocryptotermes nocens* sp. nov.

Genus *Prorhinotermes* Silvestri.
4. *Prorhinotermes luzonensis* sp. nov.
5. *Prorhinotermes gracilis* sp. nov.

Genus *Leucotermes* Silvestri sensu restricto.
6. *Leucotermes philippinensis* sp. nov.

These species, with the exception of *P. nocens,* belong to genera of widespread occurrence, known from Japan and Formosa to the north (except *Kalotermes*) and from the East Indies, Ceylon, and India to the south, and it might well have been predicted that such termite species would be found in our Philippine fauna. Therefore, the fact that the former collections made by Baker and by McGregor as well as my earlier collections failed to bring them to light might well cause surprise. The reasons for their not having been collected, however, are not far to seek. With exception of the *Planocryptotermes* species, they are not among our common forms. Nor are they conspicuous, since none of them builds mounds or exposed nests; nor do the first five species build exposed galleries, while the last one seems to be a rare species.

I wish to take this opportunity to thank Mr. R. C. McGregor, ornithologist of the Bureau of Science, for his never-failing in-

terest, his aid in collecting, and for affording me, while acting director, the facilities of the Bureau in making drawings, taking photographs, etc. To Dr. Sanji Hozawa, of the Japanese Imperial Plant Quarantine, and to Dr. Masamitsu Oshima, director of the Government Institute of Science of Formosa, both expert termitologists, I wish to express my gratitude for splendid sets of comparative material, including many cotypes or autotypes of Japanese and Formosan forms and, in the case of Doctor Oshima, for autotypes of many of his Philippine species. This material has been and will continue to be of great value in determining our Philippine termites.

All of the species described in this paper, like the other species of the lower families of the order, present a rich protozoan fauna within the hind gut. Prof. C. A. Kofoid, of the University of California, who has done much work with the protozoa of American termites and who with his staff is entering upon a comparative study of these specialized forms, has kindly consented to work up those found in our termites, and I am sending him material as rapidly as is practicable. The results of these studies should throw an interesting light on our classification, and a knowledge of the "parasites" may prove of real value in classifying the species and properly grouping the genera.

CLASSIFICATION

After careful study and correspondence with various students of termite classification I have decided to make those changes in generic and family names which, as Banks has recently pointed out, will be necessary if we follow strictly the international rules of zoölogical nomenclature. The necessity for having and observing such a set of rules is so obvious and has been so thoroughly discussed that I need not defend my action in this matter. The changes are inevitable, and the sooner we accept and use them the less difficulty will there be and the sooner will we arrive at a firm basis for our nomenclature. It was only after long hesitation and with great regret that I felt myself forced to adopt these changes which must for the time result in such an unfortunate confusion of generic names of long standing. I find that others of the younger workers in the group have passed through the same attitude of mind to arrive at the same conclusion.

The tendency is apparent, in most recent publications on this group, to do away with the awkward tripartite names by raising

the subgenera to generic rank wherever possible. Such a change seems to me to be conducive to clearness and usableness, particularly in the older genera, *Kalotermes*, *Eutermes*, and *Termes*, and I shall adopt it in my work on the Philippine termites.

With the above changes Holmgren's arrangement of families and genera is an admirable one, and I shall follow it. It may be of interest to point out here that in addition to the characters already pointed out by Holmgren as separating the three higher families it is very significant that the protozoan faunæ of the guts of the three groups are characteristic. I find none of the polyflagellate protozoa (*Hypermastigina*) in the gut of any of the Termitidæ (Metatermitidæ of Holmgren), and those of the Rhinotermitidæ (Mesotermitidæ of Holmgren), while very similar in all the genera of that family, are quite different from those found in the Kalotermitidæ (Protermitidæ of Holmgren). This is significant in connection with the position which Banks [1] gives to *Leucotermes* in his classification.

MEASUREMENTS AND TERMS

While measurements made from a small range of specimens must not be considered as fixing the variational range for a species and must be used with caution, such measurements are of undoubted value in the determination of species in a group where specific lines are by no means easy to draw, and I shall as a rule accompany my descriptions by a set of such measurements.

There has been a considerable degree of carelessness on the part of some workers in furnishing the details necessary for an intelligent use of specific descriptions. Measurements are given for body length, head length, head length without mandibles, pronotum length, etc., without making it clear just what such measurements mean. If systematic work is to accomplish anything worth while the forms of animals should be so described that they may be recognized by other investigators—not only the specialist in the group, but the biologist interested in the study of animals from other points of view, or even the layman desirous of knowing the common forms of life about him. But far too many systematic descriptions seem to be written for the specialist only, and they are often of little value to him in the absence of type material. May I go further and speak from the experience gained in entering a new systematic field? The needless use of terms of limited application should be avoided.

[1] Banks, N., and Synder, T. E., Bull. U. S. Nat. Mus. 108 (1920) 75.

Such terms as are used should be made clear. References to literature should be given whenever available. Descriptions should be comparative. Specific diagnoses are often very valuable. Systematic discussions should point out which are the nearly related species and in what particulars the new species differs from these nearly related forms. All this will add little to the labor of the systematist who has such details at his immediate command, and will add immensely to the usefulness and value of his work, not only to the general student but to the systematist so unfortunate as to lack a wide range of comparative material and a complete library.

To return to our original question: Just what is the meaning of many of the measurements used? For instance, body length? Does it mean from the distal tip of the mandible to the posterior tip of the abdomen? If so, does it mean with the head extended forward or in any position in which it may chance to be, and with the mandibles crossed or extended? Or does it mean the length of the thorax and abdomen? These are not idle questions. They involve a difference of several millimeters in animals less than a centimeter in length. In the *Macrotermes* soldier, for example, the head may assume any position, from that in which it forms a line with the long axis of the body to one in which it forms a right angle with the body, making a difference of 3 millimeters or more in total length. Again, head length without mandibles or, in the nasute soldiers, without rostrum is a very indefinite measurement unless carefully defined.

To avoid the difficulties that I have experienced in using descriptions I shall define those terms and measurements which I expect to use in my future descriptions. Some changes and additions will undoubtedly be necessary as the work develops but these will be explained as they arise.

HEAD SUTURES

Frontal suture (stem of the Y suture of some authors).—A median longitudinal suture dividing the epicranium into two equal lateral halves in the region of the vertex. Absent or imperfect in most soldiers.

Transverse suture (arms of Y suture).—Separates the vertex from the frons. Absent or imperfect in most soldiers.

Clypeofrontal suture.—Separates frons and clypeus. Absent or imperfect in most soldiers.

Clypeal suture.—Divides clypeus transversely into a distal anteclypeus and a proximal postclypeus. Lacking in some forms.

Labral suture.—Between anteclypeus and labrum.

HEAD REGIONS

The head sclerites are not clearly marked, particularly in the soldier, hence the areas or regions referred to are necessarily more or less indefinite.

Labrum ("Oberlippe" of Holmgren).—Upper lip.

Lingula (Fuller, 1915).—Anterior hyaline extension of labrum found in certain soldiers (of *Macrotermes,* for example).

Anteclypeus ("Clypeoapicale" of Holmgren).—Distal region of clypeus between labial and clypeal sutures.

Postclypeus ("Clypeobasale" of Holmgren).—Proximal region of clypeus, between clypeal and clypeofrontal sutures.

Frons, front ("Transversalband" of Holmgren).—The region bounded posteriorly by the transverse suture, anteriorly by the clypeofrontal suture, and laterally by the antennal carinæ. Not at all or imperfectly defined in most soldiers.

Frontal area (Fuller, 1915).—Forehead ("Stirn"), including frons and clypeus where transverse suture and clypeofrontal suture are both obsolete, as is the case in most soldiers. Region between fontanelle and clypeal or labral suture, since fontanelle is typically located at junction of frontal and transverse sutures.

Vertex.—The top of the head corresponding to epicranial region of insects whose head sclerites are well defined.

Occiput (occipital region).—"An indefinite area forming the convex caudal extremity of the head." (Fuller, 1915.)

Genæ.—Sides or cheeks of head. An indefinite area not delimitated in termites.

Ventral genæ.—Ventral surfaces of the head lateral to the gula including postgenæ which are not delimitated.

Gula ("menton" of Bugnion, "submentum" of Holmgren).—A distinct median ventral sclerite, articulating anteriorly with the labium.

MISCELLANEOUS HEAD STRUCTURES

Fontanelle.—A foramen in the epicranium, usually in the frontal suture at its junction with transverse suture.

Fontanelle plate.—The region of the frontal gland marked externally as a thickened or darkened area.

Antennal fossæ ("Antennenvertiefungen" of Holmgren).—The depressed lateral areas from which the antennæ arise.

Antennal foveolæ (Fuller, 1915).—The pits from bottom of which the antennæ arise.

Margins of antennal foveolæ.—Chitinous margin of antennal pits which is usually thickened, often raised, extended, or elaborated.

Antennal carinæ ("Antennenleisten" of Holmgren).—The ridges above, that is medial to, antennal fossæ.

MEASUREMENTS

Body length.—By this I mean, unless otherwise stated, the distance in a straight line from that part of the head, with exception of the antennæ or palpi, which happens to be most distal (with soldiers usually the tips of the mandibles, and with workers or adults the clypeus or labrum) to the posterior tip of the abdomen. As this measurement varies greatly with the position of the head, method of killing, preservation, etc., it should be used with caution in differentiating species.

Body length without head.—From the anterior edge of pronotum in the midline to the posterior tip of the abdomen. In using this and other measurements of body length it should be kept in mind that specimens preserved in alcohol often undergo a very distinct swelling, heavily chitinized regions becoming widely separated, as a result of which body length becomes considerably increased over that normal for the species in life.

Head length.—In the soldier this is the distance from the posteriormost part of the head to tip of the mandibles. This distance is usually measured with the head removed from the body and lying flat, in which case it is from the most posterior visible portion of the head in the midline to the tip of the mandibles; or, if these are crossed, to a line from their anteriormost point making a right angle with the long axis of the body. It may be measured with the head lying on its side from the posterior line of the head to the distal tip of the mandibles. In the adult this is the distance from the posterior border of the head to the most distal part, usually the labrum. Here again we have a measurement which varies greatly in some species with the change in position of the mandibles, and it should therefore be used with caution.

Head length without mandibles.—Measured, in soldiers, from the posterior line of the head to the labral suture, with the head

lying flat; if measured with the head on one side, from the external articulation of the mandibles to the posterior margin of the head.

Head width.—Measured at the widest point, including eyes when present. Considerable confusion has arisen from a careless use of this measurement!

Fontanelle index.—Distance from the posteriormost part of the head in the midline to the fontanelle divided by the length of the head without mandibles. I plan to use this value in certain species because of the indefiniteness which I have encountered as to the meaning of such statements as: "Fontanelle at middle of head," "Fontanelle in front of the middle of the head," etc.

Pronotum width.—Measured at the widest point.

Pronotum length.—Measured in the midline and hence the minimum length in species with notched pronotum. I suspect that this term is used by some writers, without explanation, to mean *maximum* pronotum length.

Family KALOTERMITIDÆ Banks

Protermitidæ Holmgren.

Genus **KALOTERMES** Hagen sensu restricto

Subgenus *Calotermes* sensu stricto Holmgren.

DIAGNOSIS

Adult.—Median vein of the forewing runs parallel to the cubitus and midway between it and the radial sector, simple or branched. Antennæ with 16 to 19 segments.

Soldier.—Head relatively large, elongate, arched, gradually flattened anteriorly; mandibles large, toothed but unsymmetrical, all femora enlarged. Antennæ with 13 to 18 segments, the third typically enlarged, modified, and highly chitinized. Similar to soldiers of *Neotermes*.

The species of *Kalotermes* are to be found living in the dead branches of living trees, in the dead wood of hollow or injured trees or, in some cases, in or very near the live wood. They have, therefore, the same habitat as the species of the closely related genus *Neotermes*. They form small colonies of at most a few hundred individuals consisting chiefly of larvalike "workers," a few nymphs of supplementary reproductive forms, and a few soldiers.

Kalotermes seems to have its greatest development in the Nearctic Region where Banks has reported nine species. It

seems to be replaced in the main in the Oriental Region by the species of *Neotermes* and *Glyptotermes*. The species described here is the first species of the genus *Kalotermes* reported from the Philippines, and the second from the Oriental Region, the only other species being *K. indicus* (Holmgren) reported from Macassar and Siam.

Kalotermes mcgregori sp. nov. Plate 1, figs. 1 and 2, text fig. 1.

Types.—Short-headed soldiers (from No. 188 of general collection), long-headed soldiers, "workers," and nymphs (from No. 289 of general collection), No. 24 in type collection.

Cotypes.—No. 188 in general collection (*McGregor and Light*), Culi Culi, Rizal Province, Luzon, near Manila, October 3, 1920; No. 289 in general collection (*McGregor and Light*), Culi Culi, November 19, 1920, same colony as No. 188; No. 339 (*McGregor and Light*), Rosario, Batangas Province, Luzon, December 25, 1920.

DIAGNOSIS

Body of all castes broad and flat; thorax long; head and body hairy; antennæ of soldiers with 15 to 17 segments, the third heavily chitinized and twice as long as the second. Dorsal and lateral margins of antennal foveolæ projecting. Pronotum long and very broad, much broader than the head and strongly arched, deeply concave anteriorly, its anterolateral regions projecting over the head. Abdominal terga of soldier somewhat chitinized. Living in the trunk of *ipil-ipil* (*Leucaena glauca* Benth.).

DESCRIPTIONS

Adult.—Unknown. Well-developed wing pads show (March) the median to lie parallel to and midway between the radius sector and the cubitus.

Soldier.—Head shading from yellow posteriorly to chestnut anteriorly, mandibles black; antennæ brown proximally, shading into very light yellow distally. Pronotum, mesonotum, and metanotum light brown; abdominal tergites, tibiæ and tarsi of legs yellow with a faint brownish tinge or light brown, femora lighter.

Head, body, and legs covered with a dense growth of subequal microscopic hairs; head short, thick, and directed somewhat downward, flat below, rounded laterally and above, converging slightly at both ends, bluntly rounded posteriorly. Frons rather precipitate, slightly concave in central region. A few soldiers have longer heads with straight sides converging but

little at either end and are marked by the apparent absence of eyes and by the presence of a hyaline spot near the antennæ (see text fig. 1). Mandibles (see Plate 1, fig. 1) short, stout, with a very distinct upcurve, and slightly incurved tips; their outer surfaces show a low basal hump, a slight concavity in the center, and a convexity near the distal end; left mandible a little longer than right, with three teeth on cutting edge; distal tooth double and extended distally, second triangular, somewhat truncated distally with a low posterior projection confined to the dorsal region of the mandible; basal tooth large and bluntly triangular; right mandible with two triangular teeth, with short distal and long proximal faces; proximal region of mandible roughened. Labrum about twice as broad as long, reaching to the anterior border of lower tooth of right mandible, parallel-sided, with slightly rounded anterolateral corners and a slightly convex anterior margin bearing a number of bristlelike hairs.

Antennæ with 15 to 17 segments, first segment large, cylindrical, and nearly hidden from above by the projecting dorsal margin of the antennal foveolæ; second short and cylindrical, third large and heavily chitinized, obconic with a proximal diameter less than that of the second segment; next six obconic but short and thick; more distal segments thickly clavate and lightly chitinized, apical segment oval, white. Eye hyaline and separated by less than its diameter from edge of antennal foveola (not discernible in long-headed soldiers); gula short and broad, anterior region but little less than twice as wide as narrowest portion. Legs short, femora swollen; pronotum large and considerably broader than head, much arched, making nearly a semicircle in transverse section; anterior border not notched in midline but deeply concave, the rounded anterior corners projecting far over the posterolateral regions of head; median longitudinal line distinct; broadest point of pronotum in line with the center of anterior border; lateral border receding to meet the nearly straight, weakly arcuate, posterior border; anterior margin slightly upraised and marked by a dark brown edge; mesonotum and metanotum short, mesonotum about two-thirds as long as pronotum, with notched posterior border, metanotum shorter than mesonotum. Body distinctly flattened, thoracic region as long as the abdomen in dorsal view; abdominal tergites chitinized. Practically all soldiers collected show wing pads varying in size.

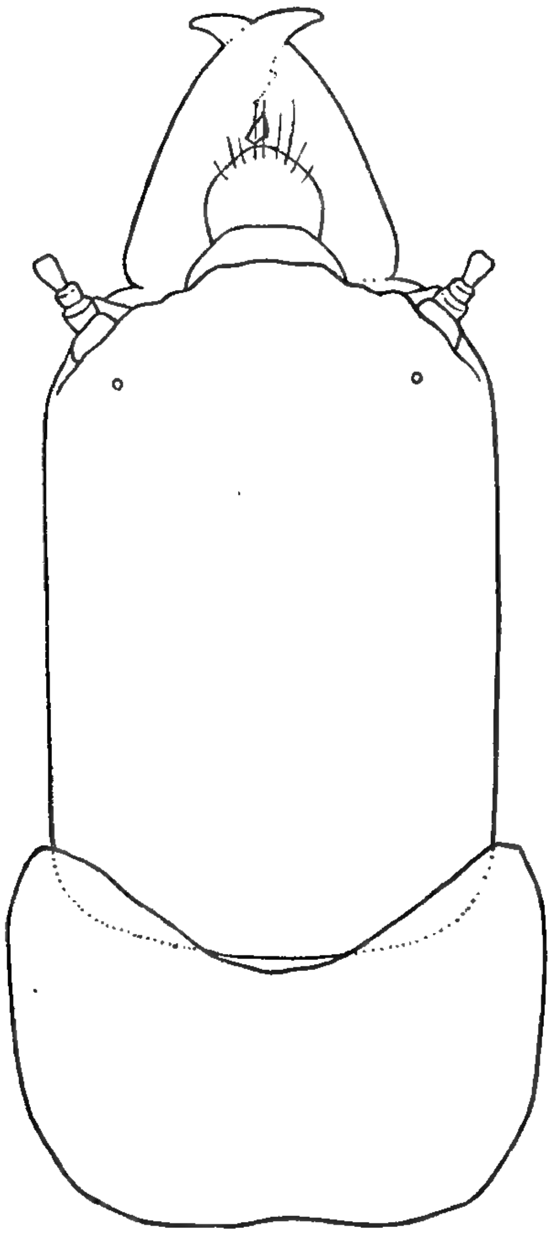


FIG. 1. *Kalotermes mcgregori* sp. nov. Outline drawing of head and pronotum of long-headed soldier. Note absence of distinct eyespots and the presence of curious hyaline spots in anterolateral region.

Measurements of Kalotermes mcgregori sp. nov., soldier.

	Short-headed soldiers.		Long-headed soldiers.
	With large wing pads.	With short wing pads.	
	mm.	*mm.*	*mm.*
Body length	7.00	6.75	9.00
Body length, without head	5.25	5.00	5.50
Head length	3.00	3.25	4.25
Mandible length, dissected:			
Left	1.35	1.25	1.50
Right	1.25		
Head length, without mandibles	2.00	2.10	2.50
Head width	1.75	1.70	1.85
Pronotum length	1.10	1.10	1.25
Pronotum width	2.25	2.00	2.25

"*Larvæ.*"—Large, broad, and thick. Antennæ with 11 to 17 segments; when 17, segments 2 and 3 incompletely separated; other segments short, thickly clavate, with thick distal and narrow proximal ends, or suborbicular.

SYSTEMATIC POSITION

While it is difficult to determine the generic position of the species of *Kalotermes* in the absence of the adult, I feel that there can be little doubt in the case of the present species. The short legs with swollen femora, the large and heavily chitinized third antennal segment, the presence of distinct wing pads and, finally, the distinct difference in shape of body, degree of chitinization, size and shape of pronotum, etc., which differentiate it from the common species of *Neotermes,* make it practically certain that we have in this species a representative of the genus *Kalotermes,* which is here reported from the Islands for the first time. Were it not for these striking differential characters one might well hesitate to report a *Kalotermes* species in the absence of the winged adult, in view of the absence of any species of this genus in the known termite fauna of Formosa and Japan to the north and the East Indies, Ceylon, etc., to the south, the only oriental species being *K. indicus* (Holmgren), known only from the adult. An examination of the venation of the wing pads of "workers" collected recently confirms

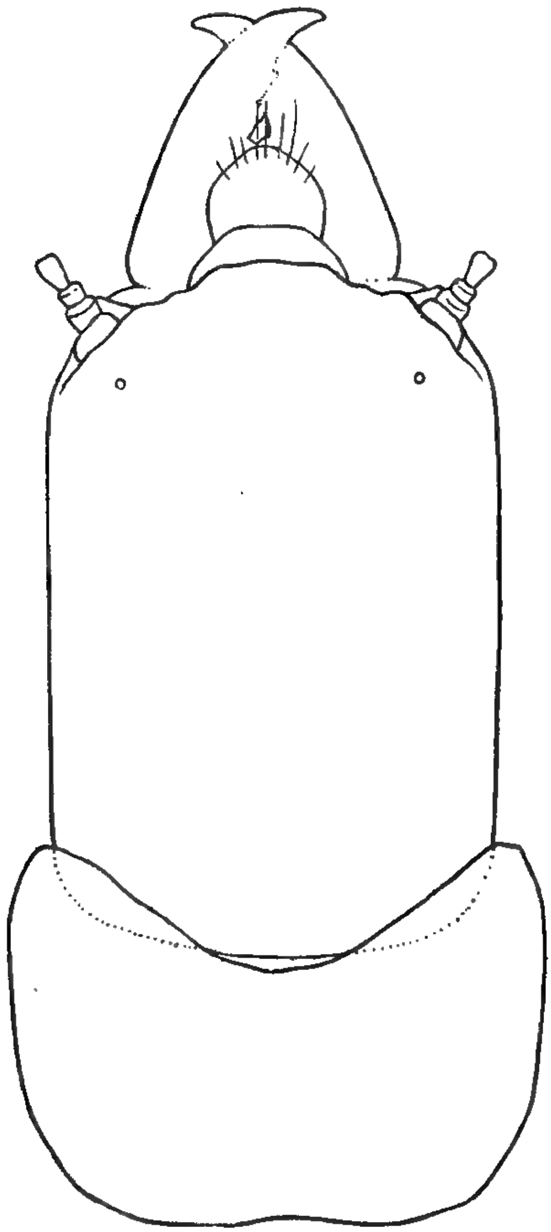


FIG. 1. *Kalotermes mcgregori* sp. nov. Outline drawing of head and pronotum of long-headed soldier. Note absence of distinct eyespots and the presence of curious hyaline spots in anterolateral region.

Measurements of Kalotermes mcgregori sp. nov., soldier.

	Short-headed soldiers.		Long-headed soldiers.
	With large wing pads.	With short wing pads.	
	mm.	*mm.*	*mm.*
Body length	7.00	6.75	9.00
Body length, without head	5.25	5.00	5.50
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Mandible length, dissected:			
Left	1.35	1.25	1.50
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my diagnosis, as the median runs parallel to and midway between the radius sector and cubitus.[2]

The protruding margin of the antennal foveolæ of the soldier, the very large, characteristically shaped pronotum, the presence of wing pads, and the characteristic toothing of the mandibles suffice to differentiate this species from other species of the genus.

I have named this distinct species in honor of Mr. R. C. McGregor, ornithologist of the Bureau of Science, who helped me to collect it and whose aid and interest have to a great extent made possible the rapid collection of local Philippine termites.

DISTRIBUTION AND BIOLOGICAL NOTES

This species was found living in tunnels very close to, if not actually within, the live wood of a small leguminous tree, *Leucaena glauca* Benth., known locally as *ipil-ipil* (Tagalog). Introduced from America, this plant is widespread about towns and country dwellings where its rapid growth, which enables it to drive out cogon grass, and its usefulness for firewood and fence posts make its propagation worth while. The very interesting question arises at once as to whether this species is found in other and native trees or is confined to this plant and, if so, whether it was introduced with the plant and is, therefore, an American species, or whether it has become adapted to this habitat since the introduction of the plant here. It seems very unlikely that plants large enough to harbor these termites were brought here, but it is by no means beyond the range of possibility. A review of the American *Kalotermes* species shows this species to be most nearly related to *K. jouteli* Banks, which it resembles in the shape of the head, the toothing of the mandible, the size of the third antennal joint, etc. It differs from it in many points, however, such as size and shape of the pronotum, shape of the third antennal joint, the projecting margins of the antennal foveolæ, etc. It appears to be a new species, therefore, whether introduced from America or not.

[2] Since writing the above I have taken two winged adult *Kalotermes* specimens in Cebu Island. Whether these belong to this or some related species cannot be determined until the series is completed in either locality. There remains the possibility that the form described here represents the soldiers and workers of *K. indicus* Holmgren known from the adult only, but the widely separated habitat makes this extremely improbable.

It was first found by Mr. McGregor and myself (No. 188) on October 3, 1920, at Culi Culi, Rizal Province, near Manila, when two soldiers and numerous "workers" were collected. Later, November 19, more extensive collections were made from the same tree, numerous soldiers and very many "larvæ", and "nymphs" being collected (No. 289). The termites were found living in channels deep in the heartwood and were apparently rapidly destroying the tree. At the first collection one side of the tree, which was dead, contained in numerous tunnels near the surface large numbers of workers and soldiers of a species of *Nasutitermes*, whose tunnels were separated internally by very thin walls from those of the *Kalotermes* colony. Such associations, whether chance relations or not, are very common. In the case of *Prorhinotermes luzonensis*, described below, three species were involved, *Prorhinotermes*, a *Hospitalitermes* species, and a *Neotermes* species. *Prorhinotermes gracilis* was also found in close association with a *Neotermes* species.

At the second collection many "nymphs" were found, some large with large wing pads, others small with but slight beginnings of wing pads but easily distinguished by their opaque white color as contrasted to the dirty white color of the posterior abdominal region of the "workers", many of which were as large as the largest nymphs but showed no wing pads. It was only at this collection that the long-headed soldiers were taken. Were it not for their presence in both colonies one might suspect that they represented a different species, so distinctly different are they from the more numerous short-headed soldiers.

A second colony, living like the first in ipil-ipil, was found by Mr. McGregor and myself on December 25, 1920, while on a collecting trip to Batangas, in the municipality of Rosario, Batangas Province, some 70 kilometers from the first colony. The finding of this second colony in the same tree species makes it seem that the species is a regular inhabitant of this tree, whether it is able to live in others or not. One or more *Neotermes* species also inhabit the ipil-ipil as they do also the guava, the *cacauate* (*Gliricidia maculata* HBK) and the *ciruelas* (*Spondias purpurea* Linn.); but many examinations of the last three trees, while producing large collections of *Neotermes*, have failed to show *Kalotermes mcgregori* or any related species.

On March 31, 1921, Mr. McGregor and I again visited the colony at Culi Culi and cut down the tree for further study in the laboratory. The termites had been driven by the dry weather to the deeper and damper portions of the tree, particularly

to the heartwood, where they were running longitudinal tunnels. The forms which I had formerly distinguished as "workers" as contrasted with the nymphs all bore large wing pads, which would seem to bear out the belief that there is no definitely differentiated worker caste, and that the opaque so-called nymphs are probably early stages of supplementary reproductive forms.

I was greatly pleased on examining the venation as seen in these wing pads to find that the median runs parallel to and midway between the radius sector and the cubitus, thus confirming my diagnosis of this as a species of *Kalotermes*.

Material for a study of the protozoan fauna of this species has been sent to Professor Kofoid.

Genus CRYPTOTERMES Banks

Subgenus *Cryptotermes* (Banks) Holmgren.

DIAGNOSIS

Adult.—Median vein bends up to unite with the radial sector beyond the middle of the wing. Wing iridescent. Antennæ of 14 to 16 segments.

Soldier.—Head short, high, and thick, bilobed anteriorly, with a vertical frontal area containing a distinct cavity. Mandibles short, humped basally, bent near the middle, weakly toothed or untoothed. Antennæ of 9 to 13 segments, the third not especially long. Pronotum with strongly concave anterior margin, not toothed. Styles reduced.

The genus *Cryptotermes* comprises species from all parts of the world. They are typically house termites, living in boards, furniture, etc., in houses or, more rarely, in dead wood of trees. They are extremely ubiquitous; there is hardly a house in the Islands but harbors these little wood destroyers or those of the very closely related genus *Planocryptotermes*. Haviland points out a similar condition in Borneo, and it is probably true in the entire tropical Indian and Malayan regions. Their presence is usually manifested by the piles of little impressed fæcal pellets which they drop from apertures in the board they are attacking. There are apparently a number of Philippine species with this habit. Their collection is made difficult by the necessity of removing or destroying boards, furniture, etc., to get at the termites.

Cryptotermes cynocephalus sp. nov. Plate 2, figs. 1 and 2.

Types.—Adults, soldier, larva, and nymph, No. 25 in type collection. Soldier, larva, and nymph from No. 67 of the general

collection, deälated adult, No. 433 of general collection, winged adult from No. 443 of general collection.

Cotypes.—No. 67 (*del Rosario*), Manila; No. 433 (*Light*), Manila; No. 443 (*Gamboa*), Manila; No. 448 (*Aguila*), Manila, in general collection.

DIAGNOSIS

Adult.—Very small, less than 5 millimeters long without wings; slender, dark, with narrow, dark wings; antennæ long, with 13 to 15 segments, third smallest.

Soldier.—Very short, about 3.25 millimeters long; head short, thick and high, bulldoglike, frontal region very strikingly developed with distinctly bilobed dorsal margin, anterior cavity deep; a distinct median dorsal cavity present; anterior and anterodorsal margins of the antennal foveola extended anteriorly to form a flat projection (spine) with rounded tip.

Larvæ and nymphs.—Small and slender.

DESCRIPTIONS

Adult.—Head flat, longer than broad; disregarding the eyes, nearly parallel-sided, sparsely haired; eyes not large or prominent, ocellus elongate in an anterodorsal direction, in contact with the eye in front of its middle. Antennæ more than twice as long as width of head, 13 to 15 segments, first segment large and cylindrical, second smaller and cylindrical, third smallest, thickly obconic, fourth to sixth gradually increasing in size, thicker than third, and with rounded distal ends, eighth to thirteenth (when 14) increasingly long and with thicker distal ends, last as long as thirteenth but narrow and oval in shape; antennæ with scattered larger hairs and a dense coat of short straight hairs. Labrum swollen, yellow; anteclypeus white; postclypeus brown, about as long as anteclypeus, remainder of head brown; pronotum brown, arched, narrower than the head (with eyes), concave anteriorly, sides somewhat rounded, posterolateral corners bluntly rounded, posterior margin nearly straight, slightly notched at center. Anterior wing scales brown, much longer than the posterior pair and reaching to or beyond the middle of the latter; abdominal tergites dark brown, metanotum yellow, giving the appearance of a transverse light band in dorsal view, abdominal sterna brown with a narrow median light area.

Wings slender, cloudy gray, iridescent; median and cubitus very slightly chitinized except at base in some specimens, costa and radius sector heavily chitinized, gray-brown; all veins and

branches as well as areas between the veins marked by papilla-like projections; base of anterior wing twice the width of base of posterior wing; forewing with radius sector and median separate at base; radius sector sends five distinct branches, and one or more small branches to the costa; median joins radius sector beyond middle of wing usually near to origin of third branch of radius sector; cubitus with eleven to thirteen branches; hind wing with six or seven branches uniting radius sector and costa, inner three large; median and radius sector usually united for a short distance at their bases; median joins radius sector distally between points of origin of second and third branches of latter (in one specimen median runs to end of wing!); cubitus with about eleven branches which tend to be more subdivided than those of forewing; cubitus of both wings bends slightly toward radius sector near level of junction of median and radius sector; a few indefinite cross veins unite cubitus and radius sector beyond junction of latter with median.

Measurements of Cryptotermes cynocephalus sp. nov., winged adult.

	mm.
Wing length	6.25
Body, without wings	4.75
Head length	1.00
Head width	0.80
Antenna length	1.65
Pronotum width	0.75
Pronotum length	0.45

Soldier.—Mandibles and anterior region of the head black shading into a dull purplish on posterior portion of the head and lateral cervical sclerites; antennæ, palpi, and distal portions of the legs light yellow, body segments and proximal portions of legs pale purplish brown. Head directed ventrally and nearly at right angles to body, short, thick and high, broadest anteriorly, suggesting the head of a bulldog (hence the specific name); anterior surface deeply excavated and extensively roughened and sculptured; lateral and dorsal margins of this frontal area produced to form a very marked, outwardly and forwardly directed flange, deeply notched in the midline, giving the head the bilobed appearance characteristic of the genus; below, this flange runs laterally on either side to form the anteriorly extended posterodorsal margin of the antennal foveola, being separated by a groove from the anterodorsal and anterior margins of the foveola which form an anteriorly projecting, laterally flattened, scalelike spine, whose upper portion

is overlapped above by the lower portion of the frontal flange; below this the ventral gena is extended to form a much smaller spine, lying over the mandibular hump.

Dorsal profile in side view high, domed posteriorly, sunken in the middle and elevated anteriorly. Seen from above there is a very distinct concavity in front of the middle of the head and behind the flange. This is narrow and elongated and, with the middorsal notch in the flange, gives the head a distinctly bilobed appearance in dorsal view. The surface of the flange and the region of the head posterior to it, particularly the sides of the dorsal cavity, are distinctly rugose.

Mandibles very short and strongly incurved, when closed protruding for a distance but little more than one-third of the anterior surface of the head; antennæ of from 9 to 12 segments, longer than the head depth; third segment smaller than the second and more heavily chitinized; pronotum strongly arched, deeply bilobed anteriorly, rounded laterally and posteriorly, the anterior and posterior regions being elevated.

Measurements of Cryptotermes cynocephalus sp. nov., soldier.

	mm
Body length	3.25
Body length, without head	2.65
Head length (posterior margin to middorsal region of flange)	0.90
Head width	0.75
Pronotum length	0.50
Pronotum width	0.85

"Workers" and nymphs.—Small and slender. Considerably smaller than those of *Planocryptotermes nocens* g. et sp. nov. which they otherwise resemble.

SYSTEMATIC POSITION

This species is characterized by the small size of all castes (less even than that of *C. cavifrons* Banks), the strikingly developed and roughened margin of the frontal region of the soldier, and the very small mandibles. The head profile of the soldier resembles that of *C. cavifrons*, but it differs from the latter and resembles *C. brevis* (Walker) in the roughened condition of the anterior and dorsal regions of the head. From the Japanese form, *C. kotoensis* Oshima, the soldier differs, among other characters, in its small, weak mandibles. From *C. domesticus* (Haviland), its nearest neighbor geographically, it differs in its smaller body size, its smaller and narrower head, its smaller mandibles, in that the anterior surface of the head

makes slightly more than a right angle with the mandibles, and in the shape and position of the spine near the antennal foveola, which in *C. cynocephalus* is simply an extension of the anterior and anterodorsal margin of the foveola. Specimens just received of the Hawaiian *Cryptotermes*-like species, kindly sent me by Mr. David T. Fullaway, entomologist of the Bureau of Agriculture, show a very striking difference among other points in their greater size. From what Mr. Fullaway has told me of the venation of the adult I am led to believe that this as yet undescribed species must be placed in another genus rather than in *Cryptotermes.*

DISTRIBUTION AND BIOLOGICAL NOTES

House termites, living in the dry, seasoned wood of planks and boards of houses, in furniture, in picture frames, etc. The specimens on which this species is based were found together with those of *Planocryptotermes nocens* sp. nov. (see below) by Prof. José I. del Rosario, of the department of chemistry, College of Liberal Arts, University of the Philippines; they were living in boards of his house and were kindly collected for me. Whether the two species were in the same boards or not I do not know since the material was collected under the impression that but one species was involved. This was true also of the second colony of this species collected which was found living in the same board with *P. nocens* sp. nov. This colony was collected by Cipriano Gamboa on March 7, 1921, and included a few winged adults (No. 443). A third, larger, colony (No. 448) was found by Paulino Aguila in the boards of a house on March 8, 1921, and contained numerous winged adults. This would seem to be very near the time for swarming, as many of the adults were fully pigmented and able to fly freely.[3] Among the hundreds of "workers" and adults, only five soldiers were found. These, like those of the colony mentioned above, were dead, as the boards had been exposed to the sun. Since

[3] Since writing the above, winged specimens of *C. cynocephalus* have been taken at various times during the months of June and July in my house in Paco, Manila, which is badly infested with house termites. These adults are never numerous and, strange to say, emerge in the early morning rather than at night, as is the habit of *Planocryptotermes* and most other termites. During the latter part of June and the early part of July a few of them were to be taken on my window curtain each morning and a deälated pair of these, our tiniest adult termites, were commonly to be seen in the early morning coursing excitedly over my washstand.

no extensive collections of house termites have been made here or elsewhere, I do not know whether *C. cynocephalus* and *P. nocens* have the same distribution; nor do we know their relative frequency. We do know that practically every house in the Islands is infested with this or other species of house termites.[4]

These termites attack isolated boards and are therefore not reached by methods which prevent the activity of the much more seriously harmful *Coptotermes, Leucotermes,* and *Eutermes* (*Microcerotermes*) species, which require a connection with the ground or a considerable moisture supply. Since the "house termites" reach their future habitat in a winged state, there is no way of preventing their presence in tropical regions where it is impossible to keep the house closed against their ingress. The only methods of combating them would be, therefore, the use of treated lumber, together with the prompt removal of any infested boards, which would presumably be prohibitive in cost. Their presence is usually demonstrated at once by the little piles of impressed pellets of fæcal matter which they throw out from their galleries: during the night, as a rule, but sometimes during the day. These little piles of yellow or orange-colored pellets (color depending upon that of the wood) are very characteristic sights in our houses in the Tropics. These termites are taken by many to be beetles because of the larvalike appearance of the worker and the curious color and shape of the soldier. Indeed they are locally known as *gorgojo* (beetle) or more commonly *bucbuc* (borer) and with the species of the genus *Planocryptotermes* are the only termites not recognized as such and given the name *anay* by Filipinos generally.

Genus **PLANOCRYPTOTERMES** novum

DIAGNOSIS

Imago.—As in *Cryptotermes* but with as many as 18[5] segments in antennæ.

[4] Collections which I made in Cebu and Negros during April and May, and further collections in Manila, have produced no new species of house-living *Cryptotermes.* They have shown *Planocryptotermes* to be common and apparently much more prevalent than *Cryptotermes* and have produced another species of *Planocryptotermes* from Manila, one from Cebu, and apparently two from Negros, all closely related to *P. nocens.* We would seem justified in the belief, therefore, that the "house termites," whose piles of fæcal pellets are to be found in nearly every dwelling in the Philippines, belong in great part to the new genus *Planocryptotermes.*

[5] In the adult of an undescribed species from Manila.

Soldier.—Similar to *Lobitermes* Holmgren. Head broad, flat and smooth, somewhat longer than broad; forehead nearly vertical, with notch in middorsal region of border. Antennæ with 11 to 14 segments, third segment not much larger than second. Mandibles distinctly toothed.

Genotype, *Planocryptotermes nocens* sp. nov.

I have founded this new genus for the species described below (*P. nocens*) and several others from other parts of the Islands to be described later. *Calotermes pinangae* (Haviland), which Holmgren places provisionally in his subgenus *Lobitermes,* probably belongs with these species. All the data I can gather from descriptions and illustrations point to that conclusion and a study of the winged form will probably show this to be true.

I had been led to the belief that the adult of *P. nocens* would agree with that of *Cryptotermes* for the reasons that *Cryptotermes*-like adults had been taken from time to time in numerous places known to be infested with *Planocryptotermes,* and that no other Kalotermitinæ adult had been taken in these vicinities except the tiny form which I have since determined to be the adult of *C. cynocephalus.* With so many houses infested with these termites it seemed extremely unlikely that the adults had escaped notice so long and as I have pointed out above the only adults captured showed the *Cryptotermes* type of wing venation.

Very recently adults found in colonies of *P. nocens* and other species of the genus have confirmed this assumption, making it necessary to establish the new genus for the group, since the adults of *Lobitermes* do not have the *Cryptotermes* venation.

The soldiers of the new genus are characterized by a larger size than those of *Cryptotermes,* by a larger head which is flattened dorsally and is considerably broader than high and somewhat longer than broad, by a more or less pronounced notch in the projecting rim of the frontal area, and by the absence of any considerable elaboration or rugosity in the frontal area which characteristically makes more than a right angle with the mandibles, which in turn are longer and slenderer than in *Cryptotermes* and distinctly toothed. They are characteristically house termites but are sometimes found in dead limbs of trees. Like *Cryptotermes* their presence is denoted by the piles of little fæcal pellets dropped from openings in the boards they inhabit (see Plate 6).

Planocryptotermes nocens sp. nov. Plate 2, figs. 3 and 4; Plates 5 and 6.

Types.—Adult, soldier, larva, and nymph, No. 26 in type collection from No. 202 of general collection.

Cotypes.—No. 39 (*del Rosario*), Manila; No. 202 (*Light*), Manila; and No. 442 (*Gamboa*), Manila, in the general collection.

DIAGNOSIS

Adult.—Antennæ long, with 16 segments, rather sparsely haired with stiff hairs of two sizes, segments 11 to 15 thickly clavate with very slender proximal ends, terminal segment shorter and much narrower, ovate; body with wings from 8.5 to 9 millimeters long, without wings from 5 to 5.5 millimeters long; pronotum slightly narrower than head.

Soldier.—Head about 1.25 millimeters long from posterior border to middorsal margin of frontal area, about 1.50 millimeters from posterior border to labral suture; about 1.25 millimeters wide; head making more than a right angle with mandibles; margin of frontal area not strongly developed, bilobed, with one deep median dorsal and two slighter lateral dorsal notches; anterior concavity shallow; two short "antennal spines," one an extension of the anteroventral margin of the antennal foveola, the other of the anterodorsal margin. Antennæ of 13 or 14 segments. House termites.

DESCRIPTION

Adult.—General color brown above, ventral surface of thorax yellow, of abdomen light brown; wings faintly iridescent, light transparent brown, anterior border darker opaque brown; head rounded posteriorly, nearly semicircular, longer than broad, with scattered spikelike hairs; Y suture visible in center of head; labrum small, somewhat swollen, yellow; antennæ typically with 16 segments, all segments rather sparsely haired with scattered, stiff, larger hairs and more numerous smaller hairs; first segment cylindrical, second shorter, slightly swollen distally, proximally heavily chitinized; third thickly obconic, about as long as second; fourth to eighth as long as broad, increasing slightly in size and becoming more smoothly rounded; ninth larger, broadly oval; tenth to fifteenth increasingly long, clavate with very slender bases; sixteenth long-oval, shorter, and slenderer.

Measurements of Planocryptotermes nocens sp. nov., winged adult.

	mm.
Body length, with wings	8.5–9.00
Body length, without wings	5.0–5.50
Head length [a]	1.16
Head width	1.08
Pronotum width	1.01
Pronotum length	0.63

[a] Posterior margin to middorsal margin of frontal area.

Soldier.—Mandibles and frontal area of head, with its margin, black, the rest of the head shading from smoky brown in front to dirty yellow at posterior surface; thorax and legs smoky, abdomen light smoky yellow, having a faint purplish tinge. Antennæ and mouth appendages light yellow to white. Head making an angle of about 45° with the body, short, broad, and square, being only slightly longer than broad and about half as high as long and showing scattered hairs, which are smaller and more numerous toward the anterior; anterior surface making an angle of more than 90° with the mandibles; posterior border nearly straight in dorsal view, with shortly rounded corners; sides and posterior surface of head sloping inward and upward to dorsal surface from a line of maximum convexity considerably below the mid-horizontal plane of the head; sides of head nearly straight and parallel.

Eyes small, hyaline and circular, lying in a considerably larger, circular elevation of the lateral surface of the head, about one and a half times their diameter from posterior margin of the antennal foveolæ, making a distinct lateral projection in dorsal view in front of which the sides converge slightly only to diverge in the low but distinct margin of the frontal area, so that the width of the head from edge to edge of the frontal margin would about equal that through the eyes; in dorsal profile the head in side view presents a sharp rise posteriorly from the border to a point one-third the distance between the posterior border and the margin of the frontal area; from this point there is a very gentle down curve to near the frontal margin and a short but distinct rise to the anterior edge of the projecting margin; dorsal surface with a very small concavity just posterior to the middorsal region of the margin of the frontal area; frontal margin less developed in middorsal region where it shows a distinct median notch, flanked on either side by a much smaller lateral notch and a second very slight notch; the margin, slightly roughened laterally to these notches, curves anteriorly, laterally, and ventrally to end in the dorsal margin of the antennal foveola

where it is laterally deflected and continuous with the posterior margin of the foveola. On either side of the mouth parts on the ventral side of the head is a dark narrow ridge (the edge of the ventral gena) running forward and laterally to culminate in a laterally flattened spinelike projection ("antennal spine") of the anteroventral margin of the antennal foveola; above this the anterior margin is reduced, giving the appearance of a deep notch internal to which the anterodorsal margin projects as a broader, still more prominent "spine."

Lying between and above the antenna and the mandible of each side is a pair of rounded elevations, the outer slightly more dorsal than the inner. Concavity of frontal area shallow and its surface smoothly rugose; mandibles distinctly thickened basally with a lateral hump, distal three-fourths slender in side view and considerably flattened dorsoventrally; left mandible less curved than right and bearing three teeth, the distal two small and the proximal one long and low; right mandible more strongly curved, with two teeth, the distal one large, with distal edge at right angles to mandible and proximal edge long, making a very obtuse angle with surface of mandible; proximal tooth of right mandible low and inconspicuous; large distal tooth of the right side fits in between the two distal teeth of left mandible when mandibles are closed, tip of the right mandible crossing under that of the left which projects beyond it; labrum white in color, projecting over the proximal half of the opened mandibles, narrow, converging distally with a distinct rounded point bearing two long, upcurved hairs at its tip with several smaller hairs just posterior to them.

Antennæ considerably longer than height of head, 13- or 14-segmented; when 13, the third obconic and nearly as long as the second; when 14, the third segment divided to form a short obconic third and a short disk-shaped fourth; first segment cylindrical, longest and thickest; first, second, and third heavily chitinized; first one or two beyond the third less so and the remainder very lightly so; first one or two segments beyond the third often nearly disk-shaped, the three beyond these become increasingly long, the proximal end more distinctly narrowed and stalked, the distal end more rounded (that is, spherical) beyond which, with exception of last, they are similar and may be described as short, thick clubs with narrow stalks and thick rounded distal regions; last two segments oval, somewhat longer and considerably narrower than preceding segments, the last only about two-thirds as wide as the next to the last. Gula small, weakly chitinized and

about half as wide as long. Pronotum narrower than head, arched, about half as long as broad, and distinctly elevated anteriorly, anterior border deeply concave, thickened, edged with black and slightly rugose, anterolateral corners rounded laterally, marked anteriorly by a distinct notch and by rugosities; lateral margins nearly straight, converging toward the posterolateral corners which round into the slightly convex posterior border.

Measurements of Planocryptotermes nocens sp. nov., soldier.

	mm.
Body length [a]	4.25 –4.60
Body length, without the head	3.50 –4.10
Head length:	
Posterior margin to middorsal margin of frontal area	1.25 –1.35
Posterior margin to labral suture	1.50
With the mandibles	2.20 –2.25
Head width	1.12 –1.25
Pronotum width	1.00 –1.00
Pronotum length	0.575–0.625

[a] Made from preserved specimens. Possibly much longer in life.

"Larva."—Reaching a length of about 5 millimeters. One of 5 millimeters shows 12 segments in the antennæ. Slender, thorax much slenderer than abdomen which is long, swollen posteriorly, and colored a yellowish brown by the wood particles and protozoa of the gut. A larva of 1.85 millimeters shows antennæ of 10 segments, segments 3, 4, 5, and 6 being rudimentary.

Nymph.—Similar to "larva" in general appearance but reaching larger size, having wing pads in various stages of development and distinct, gray, compound eyes. One about 6 millimeters in length shows 17 segments in the antennæ, 4 of them still rudimentary.

SYSTEMATIC POSITION

This species differs from *Calotermes pinangae* (Haviland), the only other described species of the genus, among other points, in the toothing of the mandible and in the greater length and breadth of the head and pronotum.

DISTRIBUTION AND BIOLOGICAL NOTES

House termites, living in boards in houses, furniture, picture frames, etc. More extensive collecting is necessary to determine the relative prevalence of the different species of this genus. My collection contains several closely related new species which I plan to describe in a future number of these notes.

So far this species has been collected only in Manila and only a few times here. Adults of this species were collected by me (No. 15) in June, 1920, with numerous dried insects in a hanging lamp shade at my former house in Ermita, Manila. I had noted the appearance of this form on June 12, which points to a protracted or irregular swarming on the part of this species. The second collection was, as noted above, by Prof. José I. del Rosario from boards in his house, with *C. cynocephalus;* the third by me from boards and moulding of a case for birds' eggs hanging on a cement wall in the laboratory. The fact that no other species of the genus has been found in boards in Manila leads to the belief that it is the common species, at least in this locality.[6] *P. nocens*, like *C. cynocephalus*, forms small colonies, eating the dry wood, without any direct connection with the ground or any external source of moisture. Most of the specimens described were found living in the wood of a box containing an exhibit of birds' eggs. The box had been hanging on a cement wall surface in the laboratory for several years without being in contact with any other wood. The assistant who hung the box tells me that there were signs of termite work when it was hung. This would seem to imply that the colony found had been in the wood for some years. Since there were less than a hundred specimens collected, of which but two were soldiers, we can get some idea of how slowly such colonies develop. Since, also, the wood was by no means all destroyed we can get an idea of how slowly they work (see photographs of work, Plates 5 and 6). Since writing the above an examination of a part of this colony (March, 1921) shows that many of the "workers" as well as the white nymphs are developing wing pads. One soldier and numerous workers were found in boards of the house of Prof. José I. del Rosario, where in association with *Cryptotermes cynocephalus* they were attacking only the boards of white lauan (*Anisoptera thurifera* Blume), a comparatively soft wood, and avoiding the harder molave and ipil, which are nearly termite proof.

[6] Since writing the above a very distinct species has been taken in Manila, one of the five species yet to be described which were mentioned above. However, winged adults of *P. nocens* have been found commonly about the lights during June and July, and adults of the other species have not, and there seems no reason therefore to change our belief that *P. nocens* is by far the commonest house termite of this locality as other closely related species of the same genus seem to be in Cebu and Negros.

Family RHINOTERMITIDÆ Banks

Mesotermitidæ Holmgren.

Genus PRORHINOTERMES Silvestri

Arrhinotermes Wasmann.

DIAGNOSIS

Adult.—Head broadly egg-shaped, nearly circular. Clypeus much broader than long, swollen. Antennæ with 19 to 22 segments. Pronotum narrower than the head. Wing membrane weakly haired, strongly reticulate. The median of both wing pairs arises from the cubitus or is lacking or arises from the radial sector in hind wing (*P. luzonensis!*).

Soldier.—Head distinctly narrowed distally. Compound eyes present, distinct or vestigial. Fontanelle distinct. From the fontanelle there runs forward a more or less distinct channel. Fontanelle gland large, extending far backward into the body. Antennæ of 16 or 17 segments.

Worker.—Clypeus rather large. With or without distinct compound eyes.

SYSTEMATIC POSITION

In 1902 Wasmann described the genus *Arrhinotermes* for a new species, *A. heimi* from Ceylon, based on adults only. In an appendix to the same article he describes *A. oceanicus*, based on adults from Cocos Island. Holmgren (1911) points out that *A. heimi* Wasmann is apparently a *Coptotermes*, and Bugnion in 1910 had reported the adults described by Wasmann as *A. heimi* to be nothing else than the adults of *Coptotermes travians* (Haviland). As Holmgren points out, therefore, according to the rules of nomenclature, *A. heimi* being considered as the type, *Arrhinotermes* becomes a synonym. Banks (1920) replaces it by *Prorhinotermes* Silvestri (1909). Holmgren, however, in view of the fact that *A. oceanicus* Wasmann described in the appendix to the same article is a true *Arrhinotermes*, retains that generic name with *A. oceanicus* Wasmann as the type. If we are to follow the rules of nomenclature, *Arrhinotermes* must be considered a synonym and I am, therefore, following Banks in this matter.

The genus *Prorhinotermes* seems to be peculiarly an island genus and while widely distributed is represented by few species and those apparently closely related. So far as I am able to ascertain, no other region has yet produced two species of this

genus. The American species is *P. simplex* (Hagen), found in the East Indies and Florida; the Formosan species is *P. japonicus* Holmgren; Ceylon has *P. flavus* (Bugnion and Popoff); Samoa, *P. inopinatus* Silvestri; Krakatoa, *P. krakataui* Holmgren; *P. oceanicus* Holmgren is found in Cocos Island; and *P. wasmanni* Holmgren, in Costa Rica. In view of this peculiar distribution of the genus it was to be expected that the Philippines would show at least one Luzon species and perhaps others from different islands. The facts in the case are a good example of the surprises which await the termite collector in the Philippines. This genus was not encountered until collections were made on the Manila-North Road where, near the Bulacan-Rizal boundary, three soldiers of *P. luzonensis* sp. nov. were found, without workers, in a stump. Later collections showed, within 50 meters of this, a small complete colony of *P. gracilis* sp. nov. (see below), with a deälated adult living in the hollow end of a branch of a guava tree. Still later collections produced from a similar situation, within a kilometer or two of the spot, the large colony with many winged adults on which the new species *P. luzonensis* is based living in close relation with a *Hospitalitermes* species and a *Neotermes* species. Extensive collections since that time have shown no other colonies in Luzon, although a few winged adults have been taken.[7]

Prorhinotermes luzonensis sp. nov. Plate 3, figs. 1 and 2, text fig. 2.

Types.—Winged adults, large and small soldiers, workers, and nymphs, No. 27 in the type collection (from No. 205 in the general collection).

Cotypes.—No. 97 (*McGregor and Light*), Rizal-Bulacan boundary, September 13, 1920; No. 205 and mixed with No. 209 in the general collection (*McGregor and Light*), Rizal Province, about one kilometer from the Rizal-Bulacan boundary on the Manila-North Road, October 4, 1920; No. 436, near No. 205 (*McGregor and Light*), March 27, 1921.

DIAGNOSIS

Adult.—Length, 7 to 8 millimeters, with wings, 11 to 12 millimeters; anterior wing, 9 millimeters long. Antennæ with 18 to 21 segments. Pronotum 1.50 millimeters broad by 0.75 to 0.85 millimeter long. Wings in appearance like those of *P. flavus*

[7] Collections recently made in the central islands of Cebu and Negros show one or more species of *Prorhinotermes* to be common in the former island and fairly so in the latter.

(Bugnion and Popoff) and in venation like those of *P. inopinatus* Silvestri but extremely variable. Median and cubitus more or less completely united in anterior wing, tending to separate and reunite, forming a closed cell; median of hind wing often arising from radial sector or from branches from both radial sector and cubitus. Radial sector thickened, particularly in outer third of each wing, and united with the costa by 8 or 9 short, thick, cross veins. All veins marked externally by tiny papillæ. Gula much broader than long, rounded posteriorly. Toothing of mandible like that of *P. japonicus* and *P. inopinatus*, not like that of *P. flavus*.

Soldier.—Large soldier with long head converging distinctly anteriorly, somewhat like *P. flavus* but with much longer body and longer maxillary palpi. Antennæ of 18 or 19 segments. Head with mandibles, 2.75 to 3 millimeters long; head width, 1.50 to 1.65 millimeters. Small soldier with head 2.50 millimeters long with mandibles, and about 1.40 millimeters wide.

DESCRIPTIONS

Adult.—Head, body, and legs yellow shading into brown in older individuals; head, base and anterior border of wings and posterior abdominal tergites often smoky. Wings diaphanous with the exception of costa and radial sector which are a grayish yellow becoming smoky near the base. Body more or less rounded, which, together with its light color and diaphanous wings, gives this termite an appearance quite different from that of most adult termites; 8 millimeters long, with wings 11 to 12 millimeters long, anterior wing 9 millimeters long. Head broadly egg-shaped, somewhat flattened behind and narrowed in front, slightly longer than broad (1.55 by 1.40 millimeters); posterior border rounded, surface flattened, slightly concave. Fontanelle small but distinct, frons incompletely delimitated, rising to meet the much-swollen postclypeus which is distinctly divided in the midline; postclypeus more than twice as broad as long and showing in front of fontanelle a shallow channel outlined in dark brown; anteclypeus small, white, four times as broad as long; labrum large, swollen, with four apical hairs in two lateral pairs; labrum a little longer than clypeus. Ocelli very near the compound eyes, small, indistinct, hyaline, an elongated oval, long axis nearly parallel to long axis of head. Antennæ with 18 to 21 joints, first large, cylindrical, heavily chitinized, second shorter, narrow and cylindrical, third and fourth smallest, disk-shaped, the others orbicular to broad-oval

with exception of apical segment which is narrower and elongated oval. Antennæ and palpi very hairy, head with a few scattered hairs. Pronotum somewhat arched transversely and longitudinally, narrower than head, nearly twice as broad as long, anterior margin weakly concave, upturned, sides upturned, rounded, receding to form rounded posterior margin. Mesonotum and metanotum much narrower than pronotum, sharply rounded posteriorly.

Wings hyaline, veins difficult to make out, with exception of costa and radial sector which are large and a yellowish gray in color and run close together and parallel to one another to near the tip where they become much narrowed, lose their color, the radial sector soon uniting with costa; costa and radial sector joined in distal third of wing by 8 or 9 short, thick, cross veins as in *P. inopinatus*. Median of anterior wings very variable, united with cubitus through greater or less portion of wing; in many wings separating and uniting once or twice to form enclosed cells (see Plate 3, fig. 1); in other wings median arises from cubitus near distal third of wing as in *P. flavus;* median or median and cubitus when united joined to radius sector by numerous, rarely branched, cross veins; cubitus giving off numerous (12 to 18) branched or unbranched veins to the posterior margin, which are united by numerous cross branches resulting in a characteristic reticulation. Median of hind wing often arising from radial sector near base of wing or by branches from radial sector and cubitus and united by numerous cross veins to radial sector and cubitus. All veins marked externally by lines of little hairlike rugosities. Anterior wing scales much larger than posterior pair; both light brown in color with exception of oblique white line and bearing a few scattered spinelike hairs and a line of similar hairs along anterior border.

Large soldier.—Head outstretched, body long and slender, body with head and mandibles as long as adult, head yellow, mandibles reddish black, thorax and abdomen light yellow, hairs scattered on head, numerous on all other parts. Head considerably longer than broad, posterior border straight, corners rounded, broadest near posterior end, converging anteriorly, head with mandibles 2.75 to 3.00 millimeters long, without mandibles 1.80 to 1.90 millimeters long, maximum width 1.40 to 1.65 millimeters, minimum width 1.00 millimeter; head very low, flattened above; ventral genæ somewhat arched; gula much narrowed at middle, nearly as broad posteriorly as in region of

articulation of maxillæ, twice as wide as at narrowest region; maxillary palpi longer than mandibles.

Fontanelle circular, aperture directed somewhat posteriorly, channel of about same diameter running forward to base of postclypeus. Antennal carinæ prominent, edged with red, projecting laterally over bases of antennæ, ending at each posterolateral corner of postclypeus in a little rounded chitinous projection, the medial articulation of the mandible; postclypeus short and narrow, more than twice as broad as long; anteclypeus very short and white; labrum short, tongue-shaped, with roundly pointed apex bearing two hairs. Mandibles as in *P. flavus* but with more gradually incurved tip; antennæ of 18 or 20 segments, much like those of adult. Compound eye distinct, hyaline, lying in midlateral line of head just behind and considerably below posterior end of antennal carina. Pronotum considerably narrower than the head, somewhat arched with a middorsal longitudinal groove, slightly concave anteriorly, with shortly rounded anterolateral corners; sides rounding broadly into the nearly straight posterior margin which is very slightly concave in its central region; pronotum 1.35 millimeters broad and 0.65 millimeter long. Pronotum broadest near anterior end, mesonotum near middle, and metanotum near posterior end; mesonotum narrower, shorter, and less heavily chitinized than pronotum.

Small soldier.—Similar to large soldier but smaller and body broader and flatter with head carried at an angle to body, broader in proportion to length and not converging anteriorly so much as in large soldier.

Measurements of Prorhinotermes luzonensis sp. nov., small soldier.

	mm.
Body length	6.00
Head length, with mandibles	2.50
Head length, without mandibles	1.60
Head width:	
Maximum	1.45
Minimum	1.00
Pronotum width	1.25
Pronotum length	0.55

Worker.—Body much like large soldier. Head like adult but much less heavily chitinized and eyes much less prominent. Head sutures not very distinct and fontanelle much larger and roughly triangular; thickened, rounded articulations at lateral ends of clypeofrontal suture distinct as in adult and soldier; antennæ and mandibles same as in adult; eyes hyaline, larger than in soldier, and in same relative position. Antennæ of 18

segments. Pronotum 1 by 0.55 millimeter, mesonotum and metanotum broader than pronotum.

Nymph.—Very numerous nymphs with swollen floatlike wing pads united in midline and similar to those described by Snyder for *P. simplex* were present in the colony. These will be studied later in connection with the findings of Thompson and Snyder.[8]

DISTRIBUTION AND BIOLOGICAL NOTES

As pointed out in the discussion under the genus, three collections of *Prorhinotermes* have been made, all in Rizal within a kilometer or two of the Rizal-Bulacan boundary. The material on which this species is based came from a single colony found in a large hollow guava tree about a kilometer from the boundary. The colony was associated with a *Hospitalitermes* species, probably *hospitalis* (Haviland) or some nearly related species such as *H. luzonensis* (Oshima). In tearing away the nest of the *Hospitalitermes* species a winged *Prorhinotermes* was seen but in the dusk was not at once recognized as a termite because of its light color, and its transparent wings and rounded body. Later, large numbers of all castes were collected, but unfortunately few data were obtained as to the relative positions and relations of the two forms. From the same place a number of specimens of *Neotermes malatensis* (Oshima) were obtained. These collections were made with Mr. R. C. McGregor on October 4, 1920, and large numbers of winged adults and nearly mature nymphs were found in the nest.[9]

Several isolated winged adults have been collected. One (No. 197) was collected by me about the lights of the University Club, San Luis Street, Manila, September 27, 1920; another (No. 212) was collected from the lights in Quiapo, Manila, October 6, 1920; and two others (Nos. 66 and 245) I found in my former house in Ermita, Manila, one on August 28, and one on October 31, 1920. As adult specimens were found in large number in the colony (No. 205) on October 4, it seems probable that the winged adults take flight during August, September, and October,[10] a few at a time probably, as the flying

[8] Thompson, C. B., and Snyder, T. E., Biol. Bull. 36 (1919) 115.

[9] Another trip to obtain more data about this colony showed the guava tree with the colony to have been destroyed, but another colony was found in another guava tree not far away (No. 436). Unfortunately it was impossible to make any extensive collections without destroying the tree.

[10] It is interesting to note in this connection that winged adults of the same or a closely related species were taken about the lights in Cebu, in May, 1921.

specimens collected were scattered individuals and I have seen no large flights. The finding of these adults in different parts of the city lends color to the belief that this species is more widespread than the limited number of colonies found would indicate. Both the house in Ermita and the University Club building are badly infested with termites, my house partly at least by *Eutermes* (*Microcerotermes*) and the club house partly at least by *Coptotermes* but possibly also by *Prorhinotermes*. These termites, being wood-dwellers and apparently building no covered galleries such as those of *Eutermes* (*Microcerotermes*) or *Coptotermes* and not dropping fæcal pellets as do many species of the Kalotermitidæ, are not easily located; hence the poverty of our collections.[11]

SYSTEMATIC POSITION

The few species of this widely separated genus have not been studied as thoroughly as might be wished. Further study of a wide range of material may show that we have a single very variable species ranging from Formosa to Samoa of which *P. japonicus*, *P. luzonensis*, *P. flavus*, and *P. inopinatus* are merely variants, or subspecies. The great variation in the wing venation of *P. luzonensis* would lend color to this belief.

From other species as now known, *P. luzonensis* differs in the following points, among others: From *P. oceanicus* Wasmann, *P. krakataui* Holmgren, and *P. simplex* Hagen in the greater size of the winged adult, and very strikingly from the soldier of *P. krakataui* in the greater number of antennal segments; from *P. wasmanni*, a description of which I have failed to find, it probably differs in its larger size, since Holmgren believes *P. wasmanni* may represent the soldiers of *P. oceanicus;* from each of the three closely related species *P. japonicus*, *P. flavus*, and *P. inopinatus* it differs in a number of minor points; from *P. flavus*, in wing venation, in toothing of mandible of adult, and in relative breadth and length of pronotum; from *P. japonicus* and *P. inopinatus*, in greater convergence of anterior end of head of large soldier, etc.

Prorhinotermes gracilis sp. nov. Text fig. 3.

Types.—Deälated adult, large soldier, small soldier, and workers, No. 28 in type collection (from No. 150 in the general collection).

[11] Through the kindness of the Bureau of Public Works I am in position to report that this species has recently been found attacking the posts on the ground floor of the Bureau of Printing building. Further inspections of public buildings will probably show them to be quite common.

Cotypes.—No. 150 of general collection (*McGregor and Light*), Rizal Province near Rizal-Bulacan boundary on Manila-North Road, September 29, 1920.

DIAGNOSIS

Adult.—Same as *P. luzonensis* but darker brown in color. Wings not known.

Soldier.—Like *P. luzonensis* but smaller, slenderer, lighter in color, head smaller, antennæ of 15 or 16 segments, segments longer and slenderer than in *P. luzonensis;* compound eyes vestigial only, not protruding as in *P. luzonensis;* pronotum much smaller than in *P. luzonensis.*

Worker.—Smaller, slenderer, lighter, antennæ of 15 segments.

DESCRIPTIONS

Adult (*deälated*).—Agrees very closely with *P. luzonensis;* color above generally darker brown, possibly due to greater age of this specimen which has made its flight while those of *P. luzonensis* were taken from the nest in the winged state. Anterior wing scales very broad, posterior ends overlapping in the midline (possibly an abnormality).

Large soldier.—In general like *P. luzonensis* but body smaller, about the size of the small soldier of *P. luzonensis,* slenderer, lighter in color, and less heavily chitinized; head smaller, pale yellow posteriorly but mandibles as dark as in *P. luzonensis;* mandibles as long as or longer than in *P. luzonensis* but slenderer; antennæ with 16 segments, third obconic, usually distinctly larger and more heavily chitinized than second or more distal segments; other segments longer and slenderer than in *P. luzonensis*; compound eye vestigial, not protruding at all, represented by a vague white area invisible except under microscope; anteclypeus extremely short; narrowest part of gula more posterior than in *P. luzonensis;* pronotum smaller in proportion than in *P. luzonensis.*

Measurements of Prorhinotermes gracilis sp. nov., large soldier.

	mm.
Body length	5.75–6.00
Head length, with mandibles	2.30–2.50
Head length, without mandibles	1.50–1.60
Head width:	
Maximum	1.25–1.30
Minimum	0.90
Pronotum width	1.00–1.05
Pronotum length	0.45–0.48

Small soldier.—Body short, flat, darker yellow, and more heavily chitinized than large soldier; head larger than in large soldier, making an angle of about 45° with body. Pronotum slightly larger. Otherwise as in large soldier.

Measurements of Prorhinotermes gracilis sp. nov., small soldier.

	mm.
Body length	4.30–5.50
Head, with mandibles	2.50–2.60
Head, without mandibles	1.45–1.50
Head width:	
Maximum	1.32–1.35
Minimum	0.90–0.95
Pronotum width	1.05
Pronotum length	0.50

Worker.—Long, slender, very lightly chitinized; thorax narrow, head light yellow, body transparent white, abdomen colored dirty salmon to brown by intestinal contents. Head flattened; posterolateral region swollen, like *P. luzonensis*, but eyes only slightly developed, projecting very slightly.

SYSTEMATIC POSITION

In view of the fact that this is the first case of two *Prorhinotermes* species found living together in the same region, and of the further fact that the two species were found in close proximity and have not been found elsewhere, it would seem an obvious inference that we are dealing here with variational forms rather than with two distinct species. A consideration of the differences between the two species makes this position untenable, however. *P. gracilis* differs much more distinctly from *P. luzonensis* than the latter differs from *P. japonicus*, *P. flavus*, or *P. inopinatus*, with regard to which it is indeed a possibility that we are dealing with a very variable species of wide distribution. The lighter color and lack of chitinization and the very slight development of the compound eyes might be due to a more sheltered life habit; the size difference might be a variation; but the very definite difference in number of antennal segments and their shape and size are difficult to explain as mere variations. A more detailed study would show a host of minor differences and, unless the anterior wing scales of the one adult of *P. gracilis* are abnormal, the wings of the two species must differ very greatly. For these reasons I have felt it impossible to avoid making this a new species, to which I have given the specific name *gracilis* because of the slender form of the worker and large soldier.

DISTRIBUTION AND BIOLOGICAL NOTES

Collected by McGregor and Light on September 29, 1920, from a hollow guava stub with living branches, near the Manila-North Road, in Rizal Province, about 100 meters from the Rizal-Bulacan boundary monument. This small colony was discovered while searching for *Neotermes*, one or more species of which are very common in guavas; in fact, a number of *Neotermes* specimens were collected at the same time, probably from tunnels near the surface of the wood. In this connection it is interesting to note that *P. luzonensis* was also found in association with, or at least in very close proximity to, *Neotermes*. The *P. gracilis* colony was found living in a mass of wood pulp, probably fæcal matter, similar to that used by *Neotermes* to plug up points of entry into a limb, and deposited by them also in some of their workings. At the time this was thought to be *Neotermes* waste, but I have not been able to verify this point and it seems probable that it was produced by the *Prorhinotermes* colony. In the center of this mass was a harder lump, apparently a royal chamber, in which was found a deälated adult male; the queen escaped or was overlooked.

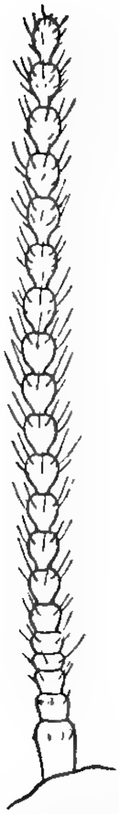


FIG. 2. *Prorhinotermes luzonensis* sp. nov. Antenna in outline for contrast with antenna of *P. gracilis* shown in next figure. × 42.

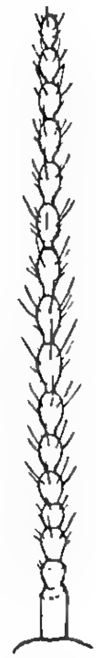


FIG. 3. *Prorhinotermes gracilis* sp. nov. Antenna in outline to contrast with that of *P. luzonensis* in preceding figure. × 42.

Genus LEUCOTERMES Silvestri sensu restricto

Subgenus *Leucotermes* sensu stricto Holmgren.

DIAGNOSIS

Adult.[12]—Yellow to brownish yellow; head oval; clypeus flat, short, and broad; labrum broad and convex; fontanelle small,

[12] From Banks and Holmgren. I have not seen the adult.

dotlike, rather far back on head. Ocelli small or lacking. Antennæ of 15 to 17 segments, segments 2, 3, and 4 very short. Gula as long as broad. Pronotum flat, concave in front and behind. Anterior wing scale much larger than hind one. Wings slightly reticulate and strongly haired. Subcosta of anterior wing not extending beyond the wing scale. Radius running near anterior border with which it is often united. Radius sector simple, parallel to the anterior border to which it is often united apically by several small branches. Median usually simple and running nearer the cubitus than the radius sector. Cubitus with 8 to 12 branches to the hind margin. Radius of hind wing separate from anterior margin only within the wing scale. Tibiæ with three apical spines. Cerci 2-segmented.

Soldier.—Head rectangular, with rather strongly inclined forehead clearly grooved in center. Clypeus short. Labrum rather long, tongue-shaped, with a sharp hyaline tip. Eyes lacking. Fontanelle in front of center of head. Mandibles with a large left and a small right basal tooth and beyond that with slight or no toothing. Pronotum flat, concave in front and behind.

Worker.—Head rounded, oval, somewhat larger than the adult. Labrum large and broad. Head sutures not distinct. Fontanelle and plate present. Antennæ with 13 to 15 segments.

Leucotermes philippinensis sp. nov. Plate 4.

Type.—No. 29 in type collection, soldier, worker, and nymph (from No. 128 of the general collection).

Cotypes.—Nos. 128 and 132 (*Miss Ursula B. Uichanco*), Manila, September 24 and 26, 1920; No. 432 (*McGregor and Light*), Manila, March 25, 1921; No. 441 (*McGregor*), Manila, April 3, 1921, in the general collection.

DIAGNOSIS

Adult.—Unknown.

Soldier.—Labrum with pointed, awl-shaped, hyaline tip, fontanelle opening from distinct reddish brown tube; antennæ of 15 segments, the first very large and strongly swollen at distal end, all segments with a dense covering of short, distally directed, incurved hairs with scattered longer hairs; coxæ and femora swollen, tibiæ slightly so, tarsi very slender and more strongly chitinized. Body slender, particularly in region of thorax, covered with a coat of hair similar to that of the antennæ, the short, incurved hairs directed posteriorly, hairing particularly heavy at posterior end of body.

Worker.—Antennæ of 15 segments, first long and curved, not distally swollen; hairs as in soldier; body slender.

Nymph.—Clypeus very greatly swollen; anterolateral corners of frons raised, projecting; antennæ of 16 or 17 segments, haired as in soldier.

DESCRIPTIONS

Adult.—Unknown.

Soldier.—Head, antennæ, and maxillary palpi pale yellow; head darker yellow anteriorly; mandibles dark, transparent, brownish red; bases of mandibles, internal mandibular articulations, margins of antennal foveolæ and "fontanelle tube" a light reddish brown; body white; anterior region of pronotum and the tarsi light yellow. Head long, parallel-sided, sides slowly rounding into rounded posterolateral corners; posterior margin straight; head dorsoventrally flattened with rounded sides ("thickly cylindrical" of Holmgren). Forehead abrupt, making angle of about 120° with the mandibles, laterally rimmed, centrally concave, dorsal rim concave; fontanelle, which is directed forward and distinctly visible internally as a brown tube, lies at posterior end of concavity; head considerably thickened anteriorly, thickest just behind level of antennæ. Mandibles short (0.825 millimeter long), strong, nearly straight, tips somewhat incurved, right untoothed, left with roughened cutting edge and two small and low but distinct teeth close together near the base. Labrum 0.45 millimeter long and 0.225 millimeter broad, tongue-shaped, ending in a very slender, awl-shaped, hyaline tip; two large hairs at base of tip, beyond which the hyaline region has a length of 0.09 millimeter. Anteclypeus very short, hyaline; medial articulations of mandibles at sides of postclypeus prominent and reddish in color.

Antennæ of 15 segments, relatively thick, much longer than mandibles, reaching about to posterior margin of head with scattered large hairs and very numerous, short, distally directed, incurved smaller hairs; basal segment very large, swollen distally; second cylindrical, larger than third; others larger than second, suborbicular to broadly oval; apical segment slightly slenderer, long-oval; margins of antennal foveolæ projecting, reddish brown. Pronotum narrower than head, more than half as long as broad, slightly concave anteriorly and less so posteriorly, broadest near anterior end, lateral margins receding gradually and rounding posteriorly into straight posterior border, slightly emarginate in center; sides depressed, anterior margin very slightly upraised; divided by middorsal longitudinal groove;

mesonotum much shorter and narrower, metanotum somewhat narrower; lateral margins of mesonotum receding, those of metanotum convex; posterior margin of each slightly emarginate in center. Coxæ, femora, and, to some extent, tibiæ swollen; tarsi very slender, strongly chitinized, yellow. Body slender, thorax particularly so, abdomen broadest near posterior end. Body and legs with scattered larger hairs and numerous smaller, incurved, posteriorly directed hairs, similar to those of the antennæ; hairing most prominent toward posterior tip of abdomen; head more sparsely haired. Cerci prominent.

Measurements of Leucotermes philippinensis sp. nov., soldier.

	mm.
Body length	4.25 –4.75
Head length	2.15 –2.25
Head, without mandibles	1.10 –1.50
Head width	0.80 –0.90
Pronotum width	0.68 –0.78
Pronotum length	0.425–0.50

Worker.—Small; body white; head very pale yellow with exception of exposed portion of mandible and mandibular articulations which are brownish yellow. Body, head, and legs covered with numerous hairs, the larger and more scattered hairs yellow, the shorter and more numerous, incurved, and posteriorly directed hairs white; body most heavily haired posteriorly, body longer than that of soldier; head broadly oval; clypeus swollen; antennæ of 15 segments, first long, curved, not distally swollen as in the soldier, apical segment slender, egg-shaped, longer than others with exception of first segment, haired as in soldier. Fontanelle and sutures not visible.

Nymph.—Much like worker but abdomen very much longer and whiter, anterior wing pads 0.10 millimeter long; head much broader behind, clypeus very greatly swollen, distinctly bilobed; anterolateral corners of frons high, projecting; compound eye projecting but little; antennæ of 16 or 17 segments, shaped and haired like worker; fontanelle and Y-suture not visible.

DISTRIBUTION AND BIOLOGICAL NOTES

The specimens on which this species are based were collected for me by Miss Ursula B. Uichanco, head of the department of biology, of the Philippine Normal School. Three soldiers, a number of workers, and several nymphs (No. 128) were collected on September 24, 1920, from galleries in cracks in the cement floor and from the door jamb of the storeroom. One soldier and a few workers (No. 132) were collected on September 26,

1920, from galleries on cement wall leading from a hole in the cement floor. On March 25, 1921, my attention was called by Mr. McGregor to termites building slender galleries on the cement supports of a porch of the Bureau of Science. These turned out to be this species, and two soldiers and numerous workers and nymphs were collected.[13] The latter showed no wing pads and it seems probable therefore that the period for emergence of the adult lies somewhere between September when the nymphs showed wing pads and March when they showed none. The species of *Leucotermes* have somewhat the same habits as *Coptotermes* but probably confine their attacks more completely to seasoned wood of buildings.[14] I hope in the future to make systematic collections in condemned buildings, which I surmise will disclose a considerably greater *Prorhinotermes*[11] and *Leucotermes* population than is at present known.

SYSTEMATIC POSITION

This species is very nearly related to *Leucotermes indicola* Wasmann. In the absence of comparative material it is impossible to be absolutely certain that we are not here dealing with a variety of that species; but from all the data available on that species (Wasmann, Holmgren) I feel satisfied that, aside from minor differences, *L. philippinensis* differs from *L. indicola* Wasmann in the much greater length of the hyaline tip of the labrum of the soldier, in the greater length of the antennæ and of the distal segments thereof, in the peculiar hairing of all castes, and in the presence of the definitely marked brown tube leading inward from the fontanelle. As the species of this subgenus are usually confined to a given region and are usually without coregional species, I have given the new species the name *philippinensis*.

[13] On March 3, 1921, Mr. McGregor brought me specimens from a colony in a house in Paco, Manila, where repairs were being made due to termite damage. Examination showed them to be *Leucotermes* and a visit to the colony furnished a large series of this species. The nest, which superficially resembled that of *Coptotermes* with its speckled yellow appearance, was much more compact with thicker walls and smaller and more rounded chambers. The nest was in the end of two floor sills. The wood attacked was not so thoroughly destroyed as in the case of attack by *Coptotermes*, particularly in the case of hardwood sills which were attacked mainly at the ends and on the sides. Pine pieces were entirely destroyed and replaced.

[14] More recently this species was found attacking growing sugar cane in an experimental plot near the Bureau of Science building. Mr. H. A. Lee, plant pathologist of the Bureau of Science, who brought this to my attention, tells me that he has frequent reports of termite damage to plants!

ILLUSTRATIONS

Plate 1

FIG. 1. *Kalotermes mcgregori* sp. nov. Head and pronotum of short-headed soldier. Mandibles opened to show toothing. (Antennæ imperfect!) × 16.5.

2. *Kalotermes mcgregori* sp. nov. Head and thorax, showing wing pads and antennæ with 17 segments. × 16.5.

Plate 2

FIG. 1. *Cryptotermes cynocephalus* sp. nov. Side view of head and part of thorax. × 30.

2. *Cryptotermes cynocephalus* sp. nov. Dorsal view of head and pronotum. × 30.
3. *Planocryptotermes nocens* sp. nov. Dorsal view of head and pronotum. × 30.
4. *Planocryptotermes nocens* sp. nov. Pronotum. × 30.

Plate 3

FIG. 1. *Prorhinotermes luzonensis* sp. nov. Head and pronotum of large soldier. × 19.

2. *Prorhinotermes luzonensis* sp. nov. Winged adult. × 9.

Plate 4

Leucotermes philippinensis sp. nov. Dorsal view of soldier. × 24.

Plate 5

FIG. 1. A piece of picture molding attacked by *Planocryptotermes nocens* sp. nov., only a thin paperlike shell remaining.

2. Cut end of above enlarged.
3. Smaller pieces of pine eaten away, leaving extremely thin outer layer.

Plate 6

A group of impressed fæcal pellets of *Planocryptotermes nocens* sp. nov. enlarged about three times.

TEXT FIGURES

FIG. 1. *Kalotermes mcgregori* sp. nov. Outline drawing of head and pronotum of long-headed soldier. Note the absence of distinct eyespots and the presence of curious hyaline spots in anterolateral region.

2. *Prorhinotermes luzonensis* sp. nov. Antenna in outline for contrast with antenna of *P. gracilis* shown in the next figure. × 42.
3. *Prorhinotermes gracilis* sp. nov. Antenna in outline to contrast with that of *P. luzonensis* in the preceding figure. × 42.

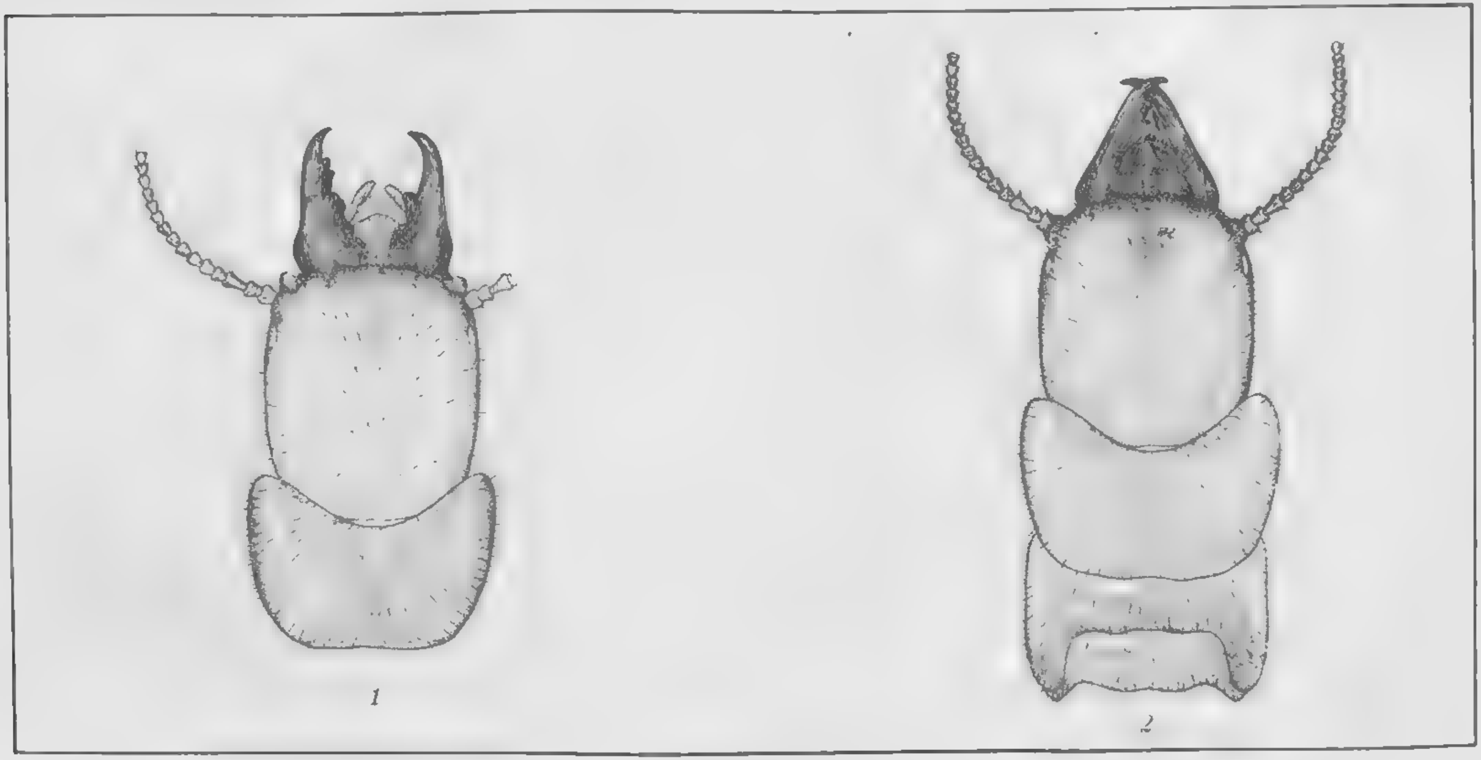
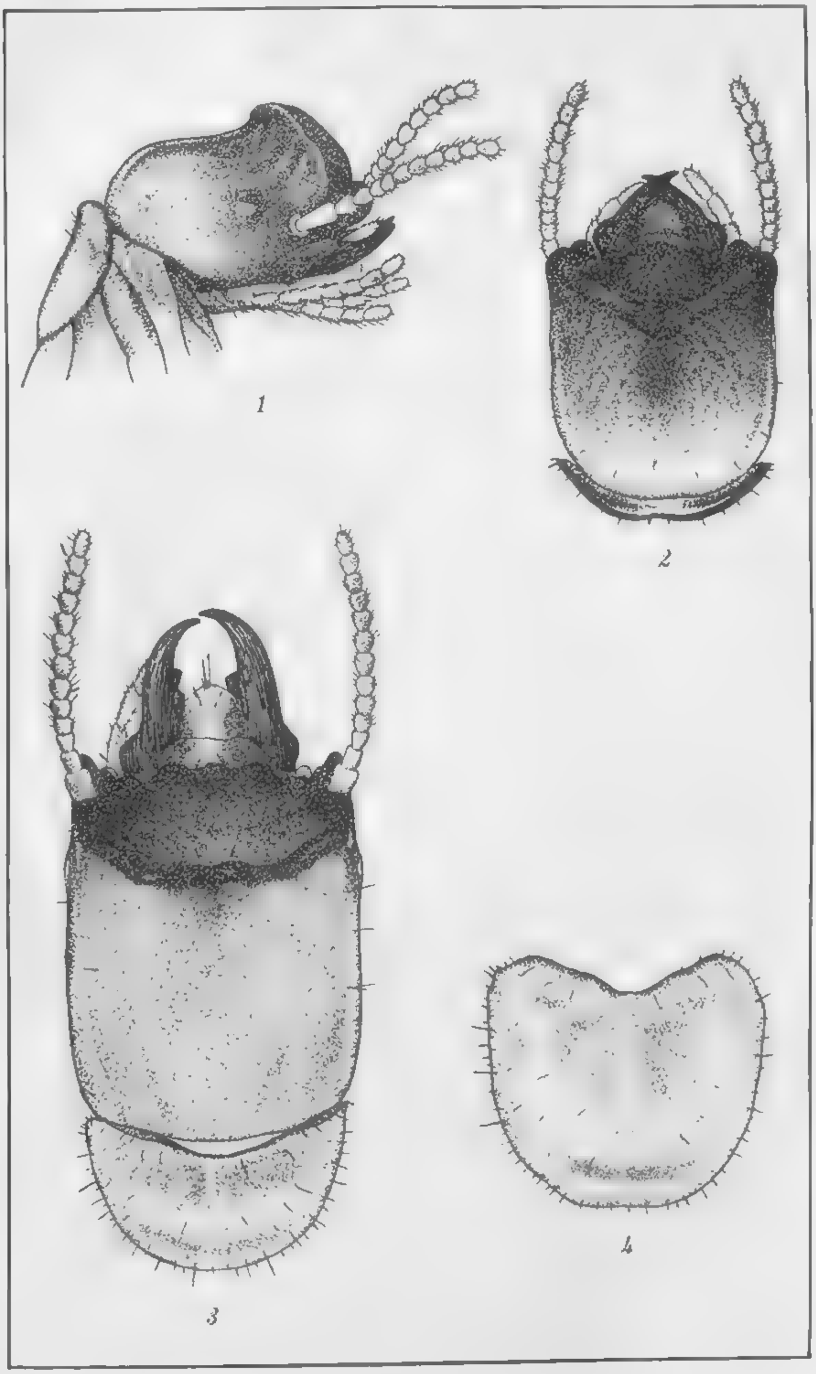


PLATE 1. CALOTERMES MCGREGORI SP. NOV.



Figs. 1 and 2. Cryptotermes cynocephalus sp. nov., head, side view and dorsal view, × 30. 3 and 4. Planocryptotermes nocens sp. nov., head and pronotum, dorsal view, × 30.

PLATE 2.

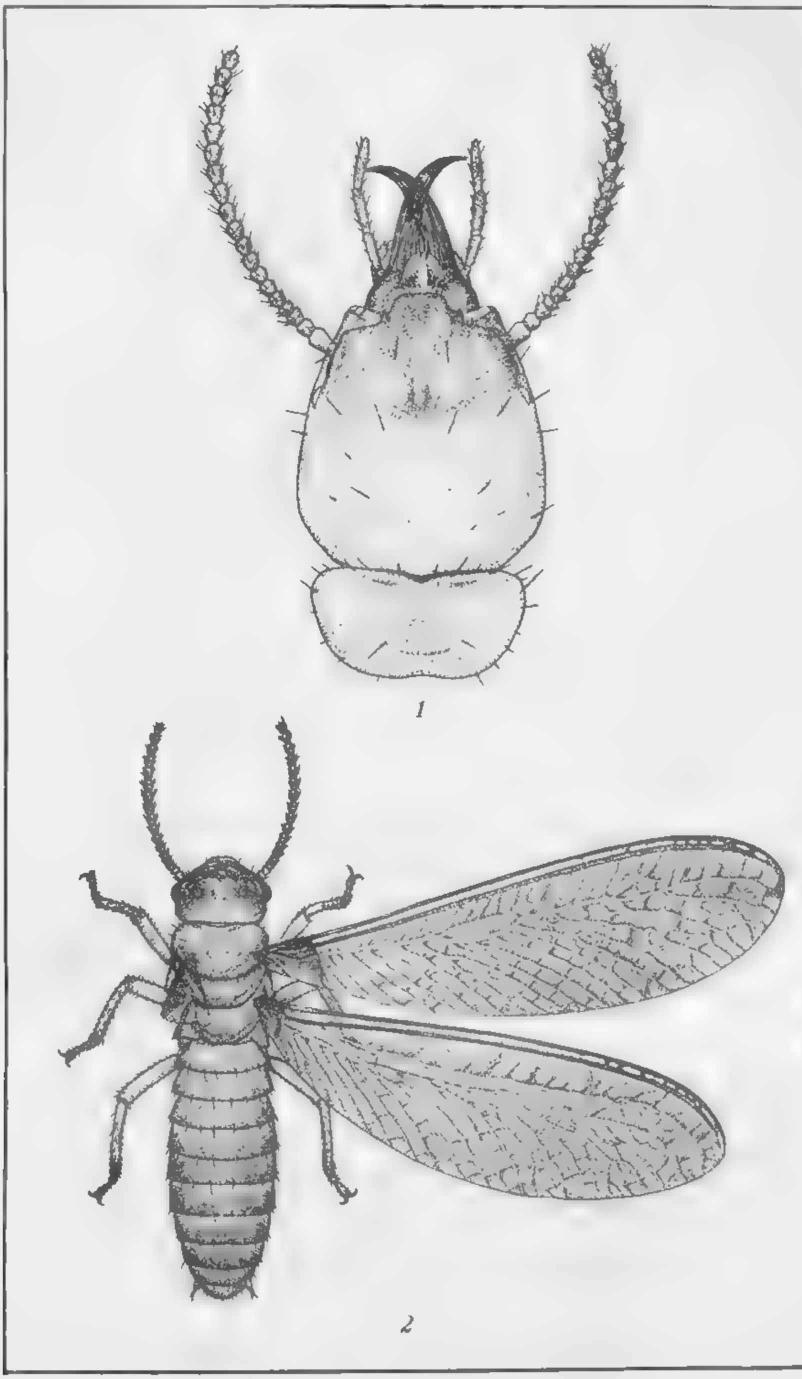


Fig. 1. Head and pronotum of large soldier, × 19. Fig. 2. Winged adult, × 9.

PLATE 3. PRORHINOTERMES LUZONENSIS SP. NOV.

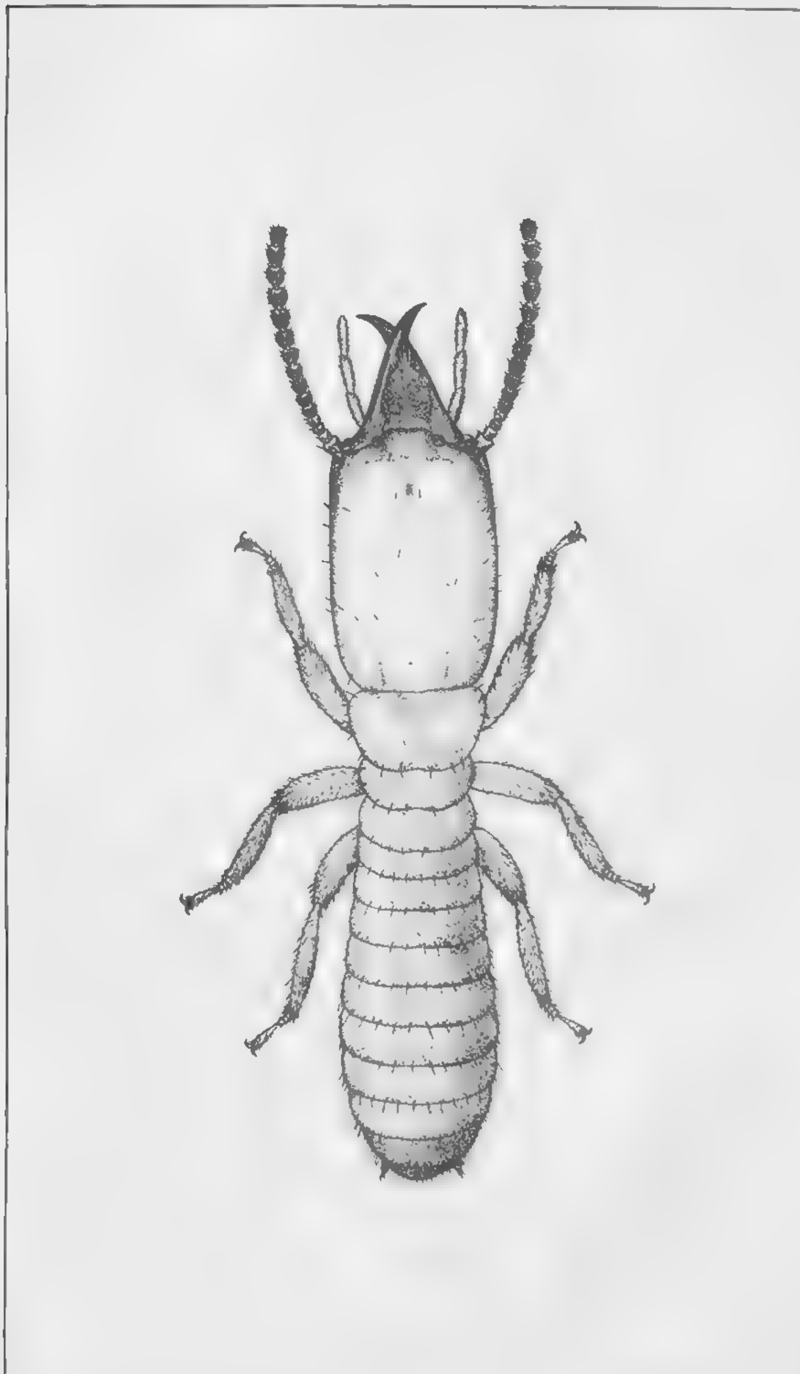


PLATE 4. LEUCOTERMES PHILIPPINENSIS SP. NOV.; DORSAL VIEW OF SOLDIER, × 24.

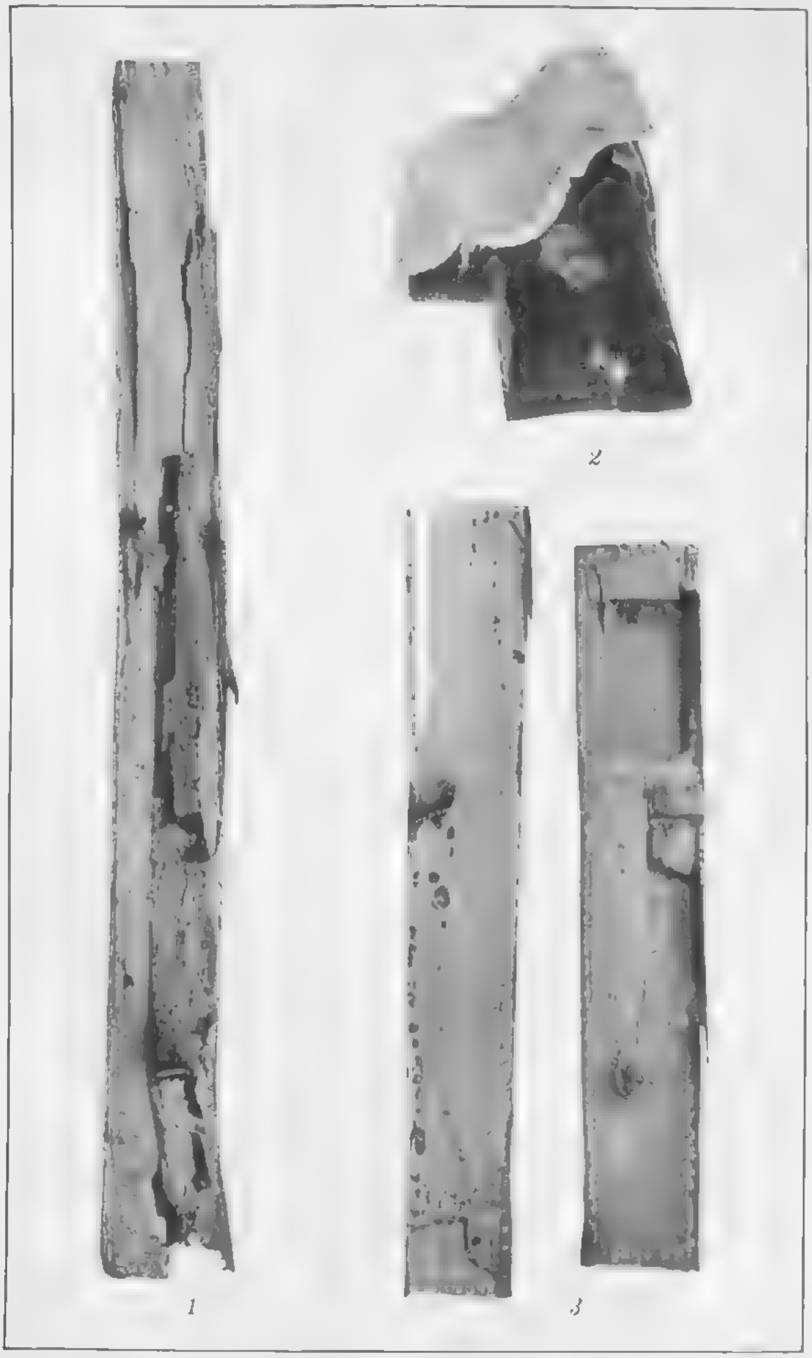


Fig. 1. A piece of picture molding attacked by Planocryptotermes nocens sp. nov., only a thin paperlike shell remaining. 2. Cut end of molding magnified. 3. Smaller pieces of pine eaten away, leaving extremely thin outer layer.

PLATE 5.

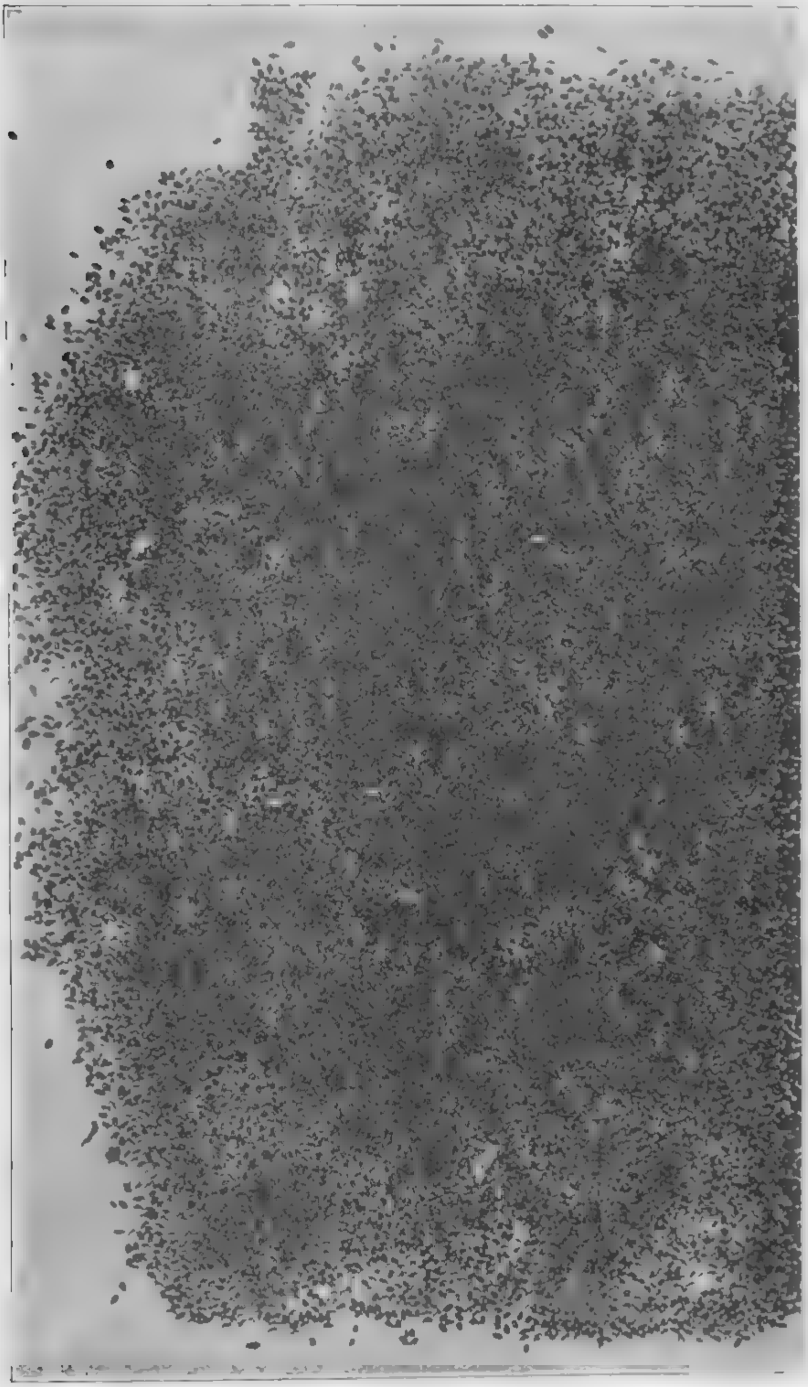


PLATE 6. A GROUP OF IMPRESSED FÆCAL PELLETS OF PLANOCRYPTOTERMES NOCENS SP. NOV.

A NEW SPECIES OF VINCENTIA FROM THE PHILIPPINES

By O. Stapf

Of the Royal Botanic Garden, Kew, England

VINCENTIA CRINITA Stapf sp. nov.

Closely allied to *V. anceps* Hk. f. (*Cladium sinclairii* Hk. f.) but differing in the 1- or 2-flowered, less compact spikelets and the wider, markedly white style-base of the ovary, slightly smaller nuts with a short pyramidal pubescent top, sharper and almost winged, broader, narrowing stipe.

Perennial, 50 cm high. Culms compressed to ancipitous, with a single leaf from halfway up to the inflorescence. Basal leaves about 9, crowded, equidistant, sheathing portion about 4 to 5 cm long, blade 15 to 22 cm by 4 to 8 mm, acute, finely striate. Panicle over 20 cm long, formed of 5 or 6 downward distant anthelae; lowest anthela supported by a bract whose sheathing portion is compressed, sharply keeled, and 2.5 cm long, whilst the ensiform, shortly acute blade is 3 cm by 4 mm; bracts of the following anthelae rapidly decreasing in size, their blades narrowly linear to subulate; branches of the lowest anthela 2, of the following 5 or more and very unequal, the longest undivided for 6 cm or more; branchlets fascicled (up to 4 in a fascicle), unequal, the longest undivided to up to 1 cm, all bearing loosely approximate clusters of spikelets; ultimate bracts ovate, cuspidate, acuminate, bright chestnut-brown to fuscous, obscurely ciliolate. Spikelets broad-ovate, laterally more or less compressed, at length more or less open with obliquely spreading glumes, about 3.5 mm long, 1- or 2-flowered, chestnut-brown to fuscous. Glumes ovate-oblong, acuminate or acute, cuspidate, 2.5 mm long, very delicately scaberulous and ciliolate, the lower 2 and the uppermost empty, the intermediate 1 or 2 fertile. Perianth none. Stamens 3, filaments much elongated at length, filiform, flexuous or in part twisted screw-fashion, remaining attached to the base of the nut. Ovary oblanceolate in outline, triquetrous, 1.2 mm long; style as long as the ovary, filiform from a thickened whitish pubescent base. Stigmas 3, slightly

shorter than the style. Nut 1.6 mm long, pale brown in the center, whitish toward the ends, the top (style base) shortly pyramidal and pubescent, 0.4 mm long; stipe narrowly linear, 0.4 mm long, its angles whitish, prominent acute. Grain 0.7 by 0.5 mm.

LUZON, Albay Province, Mount Mayon, *Bur. Sci. 2935 Mearns.*

THE PREPARATION OF TIKITIKI EXTRACT FOR THE TREATMENT OF BERIBERI

By A. H. WELLS

Chemist, Bureau of Science, Manila

The results of investigations by Funk,[1] Fraser and Stanton,[2] Chamberlain,[3] Wilcox,[4] and Cooper[5] have established the fact that beriberi is a deficiency disease. In the Philippine Islands, as in most tropical countries, the diet of the people is based upon rice. The investigations of the above-named authors, together with the findings of Braddon,[6] Highet,[7] Vedder,[8] and others have sufficiently demonstrated that beriberi can result from a diet consisting of polished rice, and that extracts of these polishings contain neuritis-preventing substances. The work of these authors has been of the greatest value in the Philippine Islands, where beriberi is very prevalent and is traceable in many cases to the use of polished rice, both domestic and imported.

In the preparation of rice for the market the glume or husk is first removed, then the grain is polished, and made white by the removal of the pericarp layer. This pericarp layer also constitutes the polishings, or tikitiki. In the Philippines tikitiki is sold as a cattle food, the best grades bringing about 4 pesos (2 dollars) per sack of 50 kilograms.

[1] Funk, Casimir, Journ. Phys. 43 (1911) 395; Journ. State Medicine 20 (1912) 341; Trans. Soc. Trop. Med. 5 (1911) 86.

[2] Fraser, Henry, and Stanton, A. T., Lancet 2 (1912) 1005; Lancet 1 (1909) 451; Lancet 2 (1910) 1755.

[3] Chamberlain, W. P., and Vedder, E. B., Philip. Journ. Sci. § B 6 (1911) 251.

[4] Wilcox, W. H., Brit. Med. Journ. No. 3081 (January 17, 1920) 73.

[5] Cooper, E. A., Journ. Hyg. 12 (1912) 436.

[6] Braddon, Leonard, Trans. Soc. Trop. Med. and Hyg. 11 (1909) 212; The cause and Prevention of Beriberi, London (1907).

[7] Highet, H. C., Studies on Beri-Beri and its Prevention in Siam, Gov. of Siam, Bangkok, Siam (July, 1912).

[8] Vedder, E. B., Philip. Journ. Sci. § B 7 (1912) 415.

Regarding the antineuritic bodies existing in rice polishings, Vedder and Williams [9] give the following conclusions:

(1) Undermilled rice may be stored for one year in a damp place without losing its protective powers against polyneuritis gallinarum. It is improbable, therefore, that a rice which originally affords protection against beriberi will lose this property by storage even in damp places.

(2) The neuritis-preventing substances or vitamines contained in rice polishings are only slightly soluble in cold 95 per cent alcohol, since three successive extractions, using a total of six liters of alcohol to each kilo of polishings, fail to remove all of the neuritis-preventing substances from rice polishings.

(3) Strong alkaline reagents such as sodium hydroxide, ammonia and barium hydroxide, destroy the neuritis-preventing vitamine, and the use of these reagents must be avoided in endeavoring to isolate this substance.

(4) Basic lead acetate does not precipitate the neuritis-preventing vitamine, and a considerable portion of this substance may be recovered from the filtrate.

(5) The therapeutic properties of an alcoholic extract of rice polishings are greatly altered by hydrolysis (treatment with five per cent hydrochloric or sulphuric acid). The unhydrolyzed extract is not poisonous, and is only slowly curative. The hydrolyzed extract is exceedingly poisonous in large doses and promptly curative in small doses.

(6) We have confirmed Funk's observations by isolating a crystalline base from an extract of rice polishings by Funk's method. This base in doses of 30 milligrams promptly cured fowls suffering from polyneuritis gallinarum.

(7) Funk's base or vitamine is present in rice polishings in considerable amounts, and only a very small portion of it can be obtained by Funk's method.

(8) Two groups of substances (purine bases, choline like bases) may be isolated from rice polishings in addition to Funk's base, and are capable of partly or wholly protecting fowls fed on polished rice against polyneuritis gallinarum, but are incapable of curing fowls that have already developed the disease. The chemical nature of these two groups of bases requires further investigation.

(9) We have confirmed the observation of Suzuki, Shimamura and Odake, that Funk's base may be precipitated from unhydrolyzed extract by tannic acid, but did not succeed in obtaining large amounts of this substance by this method.

(10) It is probable that this base or vitamine exists in food as a pyrimidine base combined as a constituent of nucleic acid, but that it is not present in the nucleins or nucleic acids that have been isolated by processes involving the use of alkalies, or heat.

(11) The administration of unhydrolyzed extract of rice polishings to cases of adult wet beriberi, or to cases suffering from acute cardiac insufficiency, results in the prompt dissipation of oedema, and relief of the cardiac symptoms.

(12) The administration of unhydrolyzed extract of rice polishings to

[9] Vedder, Edward B., Beriberi. New York, William Wood & Co. (1913) 403, 404.

cases of dry beriberi is followed by little or no improvement in the paralytic symptoms.

(13) The administration of Funk's base to cases of dry beriberi is followed by an immediate improvement in the paralytic symptoms. This should remove the last doubt that dry beriberi is caused by the deficiency of this substance in the diet. It also finally proves that dry beriberi of man and polyneuritis gallinarum are essentially the same disease.

(14) We have succeeded in curing a case of infantile beriberi (of the wet type) by administering that portion of the extract of rice polishings represented by the filtrate from the phosphotungstic precipitate. Since this filtrate does not contain Funk's base, this is evidence that wet beriberi is cured by some other substance.

(15) Conclusions 11, 12, 13 and 14 are striking confirmatory evidence for the hypothesis previously stated by Vedder and Clark, that wet beriberi and dry beriberi are two distinct conditions each being caused by the deficiency of a separate vitamine.

Chamberlain and Vedder [10] obtained cures of infantile beriberi by the use of extract of rice polishings made by extracting the fine powder with 90 or 95 per cent alcohol in the proportion of 3 liters of alcohol to each kilogram of polishings. Later Vedder and Williams decided to extract the polishings three times with successive portions of fresh 95 per cent alcohol, using 3 liters of alcohol to each kilogram of polishings for the first extraction and 1.5 liters of alcohol for each of the two following extractions. The extracts obtained were combined. Thus they observed a higher concentration of protective and curative substances in the final extract. The same authors later decided to reduce the percentage of alcohol to 90 per cent strength and to heat the extraction to 60° or 70°C. The final method for the preparation of extract of rice polishings, originated by Vedder and Williams,[11] is as follows:

THE METHOD OF PREPARING EXTRACT OF RICE POLISHINGS

Rice polishings or tiqui-tiqui may be obtained from any rice mill, but should preferably be from a recent milling. The finest grade of polishings should be carefully selected, since some of this product is very coarse and consists mostly of hulls. The tiqui-tiqui is first sifted to remove hulls and weevils. Gauze of about seven meshes to the centimeter is used for this purpose. This fine powder is weighed and mixed with 90 per cent alcohol in the proportion of three liters of alcohol to each kilo of polishings. It is then allowed to macerate for 24 hours. A glass jar or white enameled receptable [sic] serves for this pupose, and the mixture should be repeatedly stirred or shaken, since the tiqui-tiqui sinks rapidly to the bottom, forming a densely packed mass which the alcohol penetrates with difficulty.

[10] Chamberlain, W. P., and Vedder, E. B., Bull. Manila Medical Society, No. 2, 4 (1912) 26.

[11] Vedder, Edward B., Beriberi. New York, William Wood & Co. (1913) 405, 406.

During the extraction the alcohol becomes of a deep green color, due to the fat that has been dissolved out. At the end of 24 hours the alcohol is siphoned off and filtered until absolutely clear. Since a very considerable quantity remains in the tiqui-tiqui, this should be squeezed in a press, or washed with fresh alcohol, and the residuum filtered and added to the alcoholic filtrate already obtained. The extraction should then be repeated several times, again using three liters of alcohol to each kilo of polishings. This is necessary because the neuritis-preventing substances are only slightly soluble in cold 90 per cent alcohol, and experience has shown that if the polishings are not repeatedly extracted the full therapeutic action of the polishings is not obtained. The combined alcoholic filtrate is then placed in a water bath provided with a thermometer, and an electric fan is so arranged as to throw a strong current of air on the surface of the alcohol. As a result of the heat and the movement of air the alcohol rapidly evaporates. It is essential that the temperature of the extract should not be permitted to rise above 80°C., since extended observation has shown that greater heat is liable to decompose the active neuritis-preventing principle. Whenever the temperature of the extract approached [sic.] 80°C. the fire should be extinguished until the temperature drops. This process is continued until all the alcohol is evaporated. The residue is poured into a separating funnel and allowed to stand for about an hour, when it will be observed that the liquid has separated into two layers. The upper and larger portion is of a deep green color and consists of the fat. The lower and smaller layer is brown in color, of syrupy consistency, and contains a number of substances that have been extracted by the alcohol. This lower layer is carefully drawn off, leaving the fat behind. It varies in amount, but about 25 cubic centimeters usually will be obtained from each kilo of polishings. The brown syrupy fluid so obtained from one kilo of polishings is diluted to 60 cubic centimeters with distilled water, whereupon a heavy precipitate is formed. This precipitate consists of substances that were soluble in alcohol, but are insoluble in water. After allowing the mixture to stand for a while the precipitate settles and the clear fluid is filtered off. This filtrate constitutes the extract as we have used it. Each 60 cubic centimeters contains the substances that have been extracted by this method from one kilo of polishings.

In the latter part of 1913 the Bureau of Science commenced the manufacture of an extract of tikitiki for the cure of infantile beriberi. The method as outlined by Williams is as follows:

Take 25 kilos (half of a sack) of tikitiki and soak in 75 liters of 20 to 25 per cent alcohol overnight or longer. Put in a cheesecloth sack and press slowly until pressure reaches about 80,000 pounds. Obtain about 60 liters of extract, allow to stand and put in still and evaporate under 15 centimeters pressure or less. When concentrated to about 3 liters, remove, filter, and mix the clear liquid with an equal quantity of 90 per cent alcohol, which will cause precipitation. Let stand overnight, decant from the precipitate and evaporate under vacuum to about 1.7 liters. Filter if not clear, and bottle. Sterilize the bottles at about 60° C., for twenty minutes, for three consecutive days.

One cubic centimeter of this extract equals 15 grams of tikitiki. The strength of the recovered alcohol will be from 20 to 80 per cent by volume. This is diluted with water to make 20 to 30 per cent alcohol and is used repeatedly.

DOSE

Ordinary dose: Three (3) teaspoonfuls daily.
Serious cases: Double dose or more, according to requirement.

This method was in use in the Bureau of Science until January 1, 1916. The results obtained from the use of this product were so favorable that in 1916 it was decided to revise the method and to increase the production. During 1916 there was obtained a maximum possible production with the equipment at hand. Prior to this time one small copper still was utilized for concentration. At this time a much larger still, which had been used for essential oil work, was put in operation for the first distillation. By the use of these two stills the production was brought to 6,687 bottles during 1916. During 1917 and 1918 certain revisions in the methods of filtration made it possible to increase the production to 8,188 bottles in 1918. In 1919 one small Elyria glass-enameled still and a Sharples laboratory centrifuge were installed. By the aid of these units larger quantities were worked up with a quicker and more effective separation of the inactive substance and a greater concentration for the final product. Year by year the demand for the product has increased until, at the present time, the Bureau of Science is unable to supply more than a small fraction of the actual requirements of the distributors.

The finished product is placed in 50 cubic centimeter bottles, which are sealed, pasteurized, and labeled at the Bureau of Science prior to delivery to the various organizations for distribution. Such organizations as the Public Welfare Board, La Liga Nacional para la Proteccion de la Primera Infancia, and the Philippine Health Service regulate the distribution, in order to insure that treatment shall be administered to patients by competent physicians.

PRESENT METHOD OF MANUFACTURE

Rice polishings for use in this process must be free from insects, clean, and finely ground. The polishings from freshly milled rice of a new crop are preferable. The tikitiki (the rice polishings) is extracted for a period of forty-eight hours in a solution of alcohol of 25 per cent by weight (determined by use of the Abbé immersion refractometer). The proportion of

tikitiki to alcohol is one to two. Agitation is employed to a certain extent. After decantation, the residual sludge is passed to the press. The combined extracts are then passed to the distillation plant and evaporated under a pressure of 1 centimeter with a maximum temperature of 75° C. The alcohol from this distillation is recovered and passed back to the extraction plant. This first distillation is stopped when the gravity of the extract has reached 1.18 at 70° C. The sirup at this density is allowed to stand overnight, or for a sufficient length of time for it to cool and settle completely. It is then decanted and the cloudy portion passed through a Sharples supercentrifuge.

The resulting clarified sirup is further freed of inactive substances by treating it with slightly over one-third of its volume of 95 per cent ethyl alcohol. The gummy precipitate, well formed, is separated by means of the supercentrifuge and the alcoholic solution passed to the evaporator or smaller still, where the alcohol is recovered and the sirup concentrated under the same pressure and limit of temperature as before stated. The density of this final sirup is thus brought to 1.32. Upon cooling and standing overnight a flocculent precipitate of inactive susbtances forms and this is separated by again passing the sirup through the supercentrifuge. The finished product is then heated to 65°C., bottled, pasteurized for three successive days at 62.5°C., labeled, lacquered, and delivered to distributors.

Throughout the whole process as outlined above the extract comes in contact with metal only while in two of the stills that are tin lined. One still is glass enameled, although this is not absolutely essential. The precipitation, cooling, and storage are done in glass- or porcelain-lined vessels.

Due to the tikitiki being somewhat heavy, agitation is advisable in order to gain maximum extraction. Highly efficient recovery of alcohol is not obtained under the present method of coil and water condensation.

By the method outlined a clear thick sirup of good flavor is obtained. One mil of this tikitiki extract represents the active constituents of 20 grams of tikitiki, or rice polishings.

Tikitiki that has been in storage for a long time or that shows indications of mold growth has a tendency to produce an extract which is high in acidity and which is not palatable. Also, an old tikitiki is usually highly infested with beetles and other insects. Such a product not only lacks the quality stated above but gives a much lower percentage yield of finished extract.

Also, in the evaporation of extracts made from inferior grades of polishings, foaming takes place with consequent loss of time and yield.

There are two grades of tikitiki; that from the light-colored or white rice, and that from the dark or red rice. Experimentation with the tikitiki from the red rice did not give satisfactory results; the inactive substances were not easily precipitated nor wholly separable by centrifuge, and the extract obtained was of a very dark color and harsh in flavor. Further experiments will be made with the red polishings, and favorable results are expected.

The process of the manufacture of tikitiki extract at the Bureau of Science has been well established. This extract is demonstrating by its therapeutic action that it possesses a high percentage of neuritis-preventing substances and that it is a cure for infantile beriberi.

The Public Welfare Board at present (March, 1921) requires 10,000 bottles of this extract monthly. The Philippine Health Service and other organizations are purchasing tikitiki extracts made by local druggists in order to fill their requirements. Such extracts are often made without the use of vacuum, and analysis by the Bureau of Science has shown that they contain glycerine, sugars, inactive substances, and in many cases high percentages of alcohol. Many of them give very little or no precipitate with phosphotungstic acid. The great number of these preparations made and disposed of on the local market may be taken as an indication of the prevalence of the disease.

A plant with a capacity for the production of 15,000 bottles per month would permit the carrying out of a campaign for the treatment of beriberi throughout the Philippine Islands, and within one year from the time of installation of such a plant statistics on infant mortality would show a decided decrease.

Tikitiki extract manufactured by the Bureau of Science from May 20, 1914 to December 31, 1920.

	50 cc. bottles.
May 20 to December 31, 1914	1,161
January 1 to December 31, 1915	8,997
January 1 to December 31, 1916	6,687
January 1 to December 31, 1917	8,034
January 1 to December 31, 1918	8,188
January 1 to December 31, 1919	8,593
January 1 to December 31, 1920	10,870
Total	47,530

THE PHILIPPINE WASPS OF THE SUBFAMILIES SCOLIINÆ AND ELIDINÆ

By S. A. Rohwer
Honorary Custodian of Hymenoptera, United States National Museum

Subfamily SCOLIINÆ

The wasps of the subfamily Scoliinæ can be easily distinguished from their allies by the simple claws, the deeply emarginate inner margins of the eyes, the presence of only one calcarium on the intermediate tibia, the three spines on the male hypopygidium, the highly specialized tongue, and the general appearance. All of the species whose habits have been recorded prey on soil-inhabiting larvæ of Coleoptera, and some of them (as, for example, *Scolia manilae*) have proven to be of great value in reducing these coleopterous pests.

Key to Philippine genera of Scoliinæ.

1. Front wing with only two discoidal cells, the second recurrent being entirely wanting .... **Scolia Fabricius.**
   Front wing with three discoidal cells, the second recurrent present.... 2.
2. Second recurrent uniting with the first recurrent and not joining the cubitus .... **Liacos Guérin.**
   Second recurrent uniting with the second abscissa of the cubitus. **Campsomeris Lepeletier.**

Genus SCOLIA Fabricius

In the tabulating of the species of the genus *Scolia* I have accepted the current method of dividing the genus into two subgenera by the presence or absence of the second intercubitus (two or three closed cubital cells). This method of classifying the species often separates forms which are otherwise closely allied, and it seems that future work on the classification of these wasps will devise a more natural system by the use of body characters. The older writers paid but little attention to the structural details; and without a large collection, which contains at least most of the described species, it will be impossible satisfactorily to arrange these insects by any system other than the one they adopted. The clypeus, antennæ, pronotum, propodeum, first tergite, and pygidium offer useful characters, to say nothing of the shape of the head and the valuable suggestion of natural groups indicated by antigeny.

Key to Philippine species of Scolia.

1. Three closed cubital cells; subgenus *Triscolia* ..... 2.
   Two closed cubital cells; subgenus *Scolia* ..... 9.
2. Thorax and abdomen "fusco-ferrugineis;" length, 11 millimeters. S. pseudoforaminata Gribodo.
   Thorax and abdomen (mostly at least) black ..... 3.
3. Apical abdominal segments clothed with reddish hair. S. rubiginosa Fabricius.
   Hair on apical segments black ..... 4.
4. Scutellum and metanotum marked with yellow; large species ..... 5.
   Scutellum and metanotum black ..... 6.
5. Angles of pronotum and third tergite with a yellow spot. S. procer Illiger.
   Pronotum and abdomen black ..... S. scutellaris Gribodo.
6. Head marked with ferruginous or rufo-ferruginous ..... 7.
   Head entirely black ..... 8.
7. Antennæ rufo-ferruginous; abdomen subcœruleous; less than 20 millimeters ..... S. capitata Guérin.
   Antennæ black; abdomen black; over 25 millimeters. S. philippinensis sp. nov.
8. Wings purplish ..... S. bella sp. nov.
   Wings bronzy ..... S. bellina sp. nov.
9. Head black, flagellum reddish ..... S. auripennis Lepeletier.
   Head and antennæ wholly or largely reddish ..... 10.
   Head and antennæ black ..... 11.
10. Propodeum shining, sparsely punctured; antennæ entirely pale, those of the male shorter than the head and thorax ..... S. erratica Smith.
    Propodeum with large close punctures on the dorsal, lateral, and posterior surfaces; antennæ with scape black, those of the male fully as long as head and thorax ..... S. westermanni Saussure.
11. Small species, not more than 12 millimeters long .... S. manilae Ashmead. S. modesta Smith.
    Medium-sized species, over 18 millimeters long ..... 12.
12. Abdomen marked with ferruginous spots.. S. quadripustulata Fabricius.
    Abdomen entirely black ..... 13.
13. Wings violaceous ..... 14.
    Wings brownish hyaline ..... 15.
14. Head large, posterior orbits wider than eye; propodeum black; female. S. megacephala sp. nov.
    Head not especially large, posterior orbits narrower; propodeum with a bluish reflection; female ..... S. propodealis sp. nov.
15. Hair of head and thorax above black; abdomen black; female. S. luzonensis sp. nov.
    Hair of head and thorax pale; abdomen with a bluish reflection; male. S. incerta sp. nov.

Scolia (Triscolia) pseudoforaminata Gribodo.

Triscolia pseudoforaminata GRIBODO, Bull. Soc. Ent. Ital. 25 (1893) 173.

This species is not represented in the collection, but it should be easily recognized by its color which is described as "nigro-fuliginoso" with thorax and abdomen as "fusco-ferrugineis."

Wings fuscous with obscure violaceous reflections. Length, 11 millimeters. Only the male is known.

Scolia (Triscolia) rubiginosa Fabricius.

Although this species has been recorded from the Islands, it is not in the collections before me. The red hair on the apical segments should make it easily recognized.

Scolia (Triscolia) procer Illiger.

This species has been recorded from the Islands, but it is not represented in the collections I have seen from there. The typical form has a yellow mark on the first tergite which a variety recorded by Gribodo (*bimaculata* Gribodo) lacks. In size and appearance this species is much like *scutellaris*.

Scolia (Triscolia) scutellaris Gribodo.

> *Triscolia scutellaris* GRIBODO, Bull. Soc. Ent. Ital. 25 (1893) 164.
> *Scolia (Triscolia) whiteheadi* BINGHAM, Ann. Mag. Nat. Hist. VI 16 (1895) 441.

There seems to be no good reason to doubt the above synonymy as both original descriptions apply well to the specimens listed below which are certainly all the same species. Besides the absence of yellow on the pronotum and abdomen the female is readily separated from *procer* by the more prominent tubercles on the pronotum.

LUZON, Laguna Province, Mount Maquiling (*Baker 2728*) 1 male: Manila, (*George C. Lewis*). NEGROS, Occidental Negros, Bacolod, June 20, 1900 (*A. T. Clifton*) 1 female. MINDANAO, Iligan (*Baker 3139*).

Scolia (Triscolia) capitata Guérin.

This species closely resembles *Scolia westermanni*, which has only two cubital cells, but the scape and entire head are reddish ferruginous.

LUZON, Manila (*W. A. Stanton*) 1 female: Bulacan Province, Baliuag (*B. Arce*) 1 male, under Bureau of Agriculture accession No. 1591.

Scolia (Triscolia) philippinensis sp. nov.

Agrees very well with the description of *Scolia alecto* Smith except the abdomen is not iridescent and the propodeum is hardly emarginate posteriorly. The absence of yellow on the thorax and abdomen will separate it from *procer* Illiger. Apparently allied to *S. intrudens* Smith, but it cannot be assigned to that species because of the color of the wings.

Female.—Length, 32 millimeters; length of anterior wing, 30 millimeters. Two strong diverging ridges between the antennæ, the area between these ridges closely punctured and divided by a low carina; head smooth, with a few distinct punctures; antennæ stout, the apical joint truncate; pronotum not swollen laterally, the surface with rather close punctures; mesoscutum smooth, with distinct punctures laterally; scutellum and metanotum smooth, with scattered punctures on disk but with rather close punctures laterally; propodeum dorsally and caudally closely punctured, the posterior face slightly emarginate and dorsally with an indistinct striation; first tergite with a median prominence basally; pygidium with distinct striæ before tip. Black, clothed with long black hair which is especially dense on pronotum, sides of thorax, propodeum, and apical margins of abdominal segments; front, vertex, and posterior orbits to top of eye emargination ferruginous; wings purplish.

Male.—Length, 28 millimeters; length of anterior wing, 24 millimeters. Antennæ slightly longer than head and thorax; hair on ferruginous part of head the color of the integument. Agrees with female except that it lacks the ridges between the antennæ.

Type locality.—Los Baños, Laguna, Luzon.

Type.—Catalogue No. 23582, United States National Museum.

LUZON, Laguna Province, Los Baños (*Baker 1432*) 1 female and 1 male; Mount Maquiling (*Baker 3188*) 1 male: Bataan Province, Lamao (*C. R. Jones*) 1 female and 2 males, under Bureau of Agriculture accession No. 850. One of the last mentioned males is slightly larger than the type.

Scolia (Triscolia) bella sp. nov.

Evidently allied to the Bornean *S. crassiceps* Cameron, but the frons is hardly "closely" punctured, the punctuation of the scutellum is different, and the mandibles are not fringed with rufous hair. *Scolia nudata* Smith is more coarsely sculptured. *Scolia kollari* Saussure is said to have the lateral dorsal area of the propodeum more sparsely sculptured than the median area. *Scolia macrocephala* Gribodo has the clypeus different and the anterior surface of the first tergite impunctate.

Female.—Length, 17 millimeters; length of anterior wing, 13 millimeters. Head large, as wide as thorax, posterior orbits wider than the greatest transverse diameter of eye; clypeus shining, with a few large punctures basally, convex medianly,

apical median portion depressed and broadly rounded; an oblique, low, rounded ridge over each antennal fossa; front convex, with large, well-separated punctures; vertex and posterior orbits practically impunctate; occiput with rather close, small punctures; ocelli rather small; postocellar line somewhat less than half as long as the ocellocular line; antennæ stout, flagellar joints punctured, apical joint truncate, not as long as the two preceding; pronotum rounded, impunctate medianly, laterally uniformly rather closely punctured; scutum with sparse, large punctures except for two rather narrow, linear areas sublaterally; scutellum, metanotum, and dorsal part of propodeum (except an impunctate area on inner basal part of each lateral area) with rather large uniform punctures; tegulæ, except at extreme base, impunctate; lateral posterior areas of propodeum punctured, the median area impunctate; sides of propodeum sparsely punctured, separated from dorsal surface by a sharp carina; mesepisternum coarsely punctured; abdomen shining, very sparsely punctured; first tergite short, the anterior surface with distinct but small punctures; apical tergites with large, rather close punctures; posterior calcaria stout, short, the longer one not half as long as basitarsus; second sternite truncate basally; pygidium rounded apically, shining, sparsely punctured; hypopygidium shining, lateral angles rather small, median lobe trapezoidal in outline except for rounded apex. Black, basal tergites with a bluish reflection; hair rather sparse, black; wings uniformly deep violaceous.

Male.—Length, 14 millimeters; length of anterior wing, 11 millimeters. Head of normal size, subshining; frons with rather close, large punctures; vertex and occiput sparsely punctured; postocellar line but little shorter than the ocellocular line; clypeus convex, punctured laterally, apical margin truncate; basal flagellar joints short (antennæ wanting beyond fifth joint); scutum uniformly punctured; punctuation of scutellum, metanotum, and propodeum like female but sparser; mesepisternum very coarsely punctured; pygidium shining, sparsely punctured, obtusely angled apically; abdomen punctured like female. Colored like female except that in some lights there seems to be a sparse grayish pile on sides of thorax.

Type locality.—Puerto Princesa, Palawan.

Allotype locality.—Baguio, Luzon.

Type.—Catalogue No. 23583, United States National Museum.

LUZON, Mountain Province, Baguio (*W. Robinson*) 1 male, allotype. PANAY, Antique Province, Culasi, June, 1918 (*McGregor*) 1 female, paratype. PALAWAN, Puerto Princesa (*Baker*) 1 female.

Scolia (Triscolia) bellina sp. nov.

Closely allied to *Scolia bella*, but smaller, the wings bronzy, the longer calcarium of hind tibia half as long as basitarsus, etc.

Female.—Length, 13 millimeters; length of anterior wing, 10 millimeters. Head large, as wide as thorax, posterior orbits as broad as greatest transverse diameter of eye, shining; frons convex and together with vertex and occiput with rather small, well-separated punctures; ocelli small; postocellar line half as long as the ocellocular line; oblique ridges above antennæ narrow; clypeus shining, practically impunctate, convex medianly, the apical median margin depressed, and rounded; antennæ short, shining, apical flagellar joints punctured, apical joint truncate, shorter than two preceding; pronotum rounded, impunctate medianly, uniformly punctured laterally; tegulæ, except basally, impunctate; scutum uniformly covered with rather large punctures; scutellum, metanotum, and dorsal part of propodeum (except impunctate inner half of lateral areas) with distinct, rather large punctures; posterior face of propodeum punctured like the dorsal surface except more sparsely so; sides of propodeum with small, well-separated punctures, separated from the dorsal surface by a distinct carina, calcaria of hind tibiæ stout, the longer one-half as long as basitarsus; abdomen shining, very sparsely punctured, the apical segments more closely so; first tergite short, without carinæ or tubercules, its anterior face with small distinct punctures; pygidium shining, sparsely punctured, apical margin rounded; hypopygidium with small lateral spines, median lobe truncate. Black, basal tergites with a bluish reflection; hair sparse and black; wings uniformly deep bronzy.

Male.—Length, 11 millimeters; length of anterior wing, 9 millimeters. Agrees closely with the female. Head of normal size; ocellocular line one and one-half times as long as postocellar line; antennæ shorter than head and thorax, the apical joint obliquely truncate and but little longer than the preceding; longer calcarium of hind tibia not half as long as basitarsus; pygidium and hypopygidium shining, sparsely punctured, their apical margins obtusely angled. Color as in female, except that the legs and underparts of thorax have some of the hairs whitish.

Type locality.—Davao, Mindanao.

Type.—Catalogue No. 23584, United States National Museum.

LUZON, Tayabas Province, Malinao (*Baker 5230*) 1 male paratype. MINDANAO, Davao (*Baker 6921*) 1 female, (*Baker 6907*) 1 male.

Scolia (Scolia) auripennis Lepeletier.

Recorded from the Islands but not in the Philippine collection before me.

Scolia (Scolia) erratica Smith.

Scolia erratica SMITH, Cat. Hym. Brit. Mus. 3 (1855) 88; TURNER, Ann. Mag. Nat. Hist. VIII 8 (1911) 619.

Scolia molesta SAUSSURE and SICHEL, Cat. Spec. Gen. Scolia (1864) 111.

The specimens assigned to this species agree well with Saussure's account and are easily distinguished from *Scolia westermanni* by the sparse punctuation of the propodeum and the shorter antenna of the male.

LUZON, Laguna Province, Los Baños (*Baker 832*) 1 female; Mount Maquiling, 1 male. PANAY, Antique Province, Culasi, June 1, 1918 (*McGregor*) 1 male.

Scolia (Scolia) westermanni Saussure.

Scolia westermanni SAUSSURE, Ann. Soc. Ent. France III 6 (1858) 212; TURNER, Ann. Mag. Nat. Hist. VIII 8 (1911) 619.

Scolia erratica SAUSSURE and SICHEL, Cat. Spec. Gen. Scolia (1864) 111.

A single male collected by B. Arce and under accession No. 1591, Bureau of Agriculture, P. I.

Scolia (Scolia) manilae Ashmead.

There is practically no doubt that this species was first described by Smith under the name *Scolia modesta*, but inasmuch as none of the females before me have "a round macula" on the third segment (the mark when present being an oval or elongate spot) and none of the males agree with Smith's description in having the scutellum, metanotum, and propodeum marked with yellow, it seems desirable to delay synonymizing Ashmead's name until Smith's type can be examined.

Most of the specimens of this common species show very little variation. One female from Los Baños, however, has the abdomen entirely without yellow marks, but two other females from the same locality (one under Baker No. 1709) have the marks of the abdomen reduced to a varying degree thus con-

necting this single specimen with the others. The mark on the third tergite varies some in size and shape. Two males have the abdominal marks larger than usual but otherwise do not differ. One male, which may be somewhat immature, has the second and third tergites slightly reddish.

LUZON, Mountain Province, Baguio (*W. Robinson*) (*Baker*): Laguna Province, Los Baños (*Baker 1708, 1709, 1710, 1836*): Union Province, Bauang (*Baker 4963*): Manila (*W. A. Stanton*). NEGROS, May, 1911 (*C. V. Piper*). LEYTE, Tacloban (*Baker*). PANAY, Antique Province, Culasi, June, 1918 (*McGregor*). MINDANAO, Davao (*Baker 6906*); Dapitan (*Baker 3194*). PALAWAN, Puerto Princesa (*Baker*).

Scolia (Scolia) modesta Smith.

See above remarks under *Scolia manilae* Ashmead. From the description the specimens described by Smith can be separated from *manilae* in the female by "a round macula," on the third tergite, and in the male by the presence of yellow marks on the scutellum, metanotum, and propodeum.

Scolia (Scolia) quadripustulata Fabricius.

This species has been recorded from the Islands but is not in the material before me. The typical form has four ferruginous or yellowish marks on the abdomen; the wings are "nigro-chalybeis," and the head and thorax are almost impunctate. The hair is described as black. Some varieties with the abdomen entirely black have been described, and it is possible that the record of the species occurring in the Islands is based on an erroneous identification. Length, 15 to 20 millimeters.

Scolia (Scolia) megacephala sp. nov.

The large head allies this species with *Scolia cephalotes* Burmeister, but the black legs will readily distinguish it from that species. Disregarding the head it seems more closely allied to *S. redtenbacheri* Saussure. The large head seems to ally this species with the species of *Triscolia* with large heads.

Female.—Length, 21 millimeters; length of anterior wing, 17 millimeters. Head large, as wide as thorax, shining; vertex, occiput, and cheeks very sparsely punctured; posterior orbits somewhat broader than greatest transverse diameter of eye; clypeus shining, with large, separated punctures which are practically wanting on convex median portion, the apical margin depressed medianly and produced into a broad truncate lobe;

an oblique rounded ridge above and inside of each antennal fovea; front convex, with large sparse punctures; lateral ocelli small; ocellocular line one and one-half times as long as postocellar line; flagellum punctured, the apical joint truncate and not as long as two preceding; pronotum rounded, uniformly punctured; tegulæ with a few punctures; scutum shining, with large, separate punctures which are wanting in a rather small V-shaped area; scutellum and metanotum shining, uniformly punctured; propodeum emarginate posteriorly, dorsally with distinct punctures which are uniform except for polished, somewhat triangular-shaped areas at base of lateral area; posterior face of propodeum sparsely punctured, the median portion with very few punctures; sides of propodeum with small separated punctures; mesepisternum coarsely reticulate-punctate; posterior calcaria simple, the longer one not quite half as long as basitarsus; abdomen shining, very sparsely punctured; first tergite subcampanulate, without tubercules or carinæ, its anterior face rather closely punctured; second sternite subtuberculate in basal middle; pygidium rather narrowly rounded apically, with rather close, irregular punctures; hypopygidium with lateral angles rather small and narrow, median lobe trapezoidal in outline. Black, basal tergites with a distinct violaceous reflection; hair black; wings deep violaceous to apex.

Type locality.—Mount Maquiling, Laguna, Luzon.

Type.—Catalogue No. 23585, United States National Museum.

LUZON, Mountain Province, Baguio (*Baker*) 1 female: Laguna Province, Mount Maquiling (*Baker*) 2 females (one the type). PANAY, Antique Province, Culasi, May 13, 1918 (*McGregor*).

Scolia (Scolia) propodealis sp. nov.

Evidently allied to *Scolia carbonaria* Saussure and *S. redtenbacheri* Saussure but differs from the former in having both calcaria of hind tibiæ simple and from the latter in larger size and more sparsely and finely punctured thorax.

Female.—Length, 25 millimeters; length of anterior wing, 24 millimeters. Clypeus flat, finely granular and with a few large punctures basally and an interrupted row a short distance before margin, the anterior margin broadly, roundly, slightly produced medianly; front with a transverse depression medianly, below which is a dorsoventral impressed line; head shining, not as wide as thorax, posterior orbits not swollen, as broad as greatest

transverse diameter of eye; front and vertex with a few large punctures; postocellar line about half as long as the ocellocular line; antennæ stout, the apical joint truncate and as long as two preceding; pronotum rounded and with uniform punctures which are separated by a distance somewhat greater than their diameter; tegulæ with quite a few punctures; scutum polished medianly; laterally with well-separated punctures; scutellum and metanotum with rather close punctures; propodeum shining, deeply emarginate posteriorly, the central area dorsally and posteriorly and the sides of the lateral areas dorsally with rather small, well-separated punctures; sides of thorax shining, mesepisternum punctured like dorsal part of propodeum; posterior calcaria simple, the longer one somewhat more than half as long as basitarsus; first tergite without a tubercule or carina, campanulate, more closely punctured at base above; abdomen shining, very sparsely punctured; pygidium rounded, coarsely, irregularly punctured; hypopygidium sharply angled laterally, medianly produced into a broad, rounded, nearly parallel-sided lobe. Black, propodeum and basal tergites with a slight violaceous reflection; hair black; wings violaceous, beyond the venation more brownish.

Type locality.—Mount Maquiling, Laguna, Luzon.

Type.—Catalogue No. 23596, United States National Museum.

Described from one female received from C. F. Baker.

Scolia (Scolia) luzonensis sp. nov.

The paler wings and pale hair on the sides of the thorax readily separate this from other Philippine species. It is possibly allied to *Scolia melanosoma* Saussure.

Female.—Length, 22 millimeters; length of anterior wing, 17 millimeters. Head normal, not as wide as thorax and with narrow posterior orbits, closely punctured, except for a transverse impunctate area behind ocelli and the more widely separated punctures on the front; clypeus uniformly punctured, convex medianly, the apical margin depressed, rounded medianly and with transverse aciculations; a small shining tubercule between bases of antennæ; a narrow, oblique flange above each antennal fovea; front with a low, incomplete, transverse ridge which medianly is impressed by a line so as to form a broad V; area surrounding ocelli more sparsely punctured; ocelli of equal size, the postocellar line less than half as long as the ocellocular line; antennæ stout, the flagellum punctured, the apical joint truncate and not quite as long as the two preceding; pronotum

rounded, closely covered with long, piceous hair which obscures the surface, the posterior margin with a fringe of short, yellowish hair; tegulæ impunctate; scutum and scutellum closely punctured laterally, medianly impunctate; metanotum uniformly, rather sparsely punctured; propodeum nearly truncate, smooth shining, with a group of close punctures at base of median area and on lateral area just before middle; sides of propodeum nearly uniformly punctured, sharply separated from dorsal and posterior aspect; posterior calcaria yellowish, simple, the longer one more than half as long as basitarsus; abdomen shining, sparsely punctured; first tergite short, without a tubercle or carina, its anterior surface sculptured like the dorsal; base of second sternite rounded; pygidium rounded apically, densely clothed with black bristles; hypopygidium broadly rounded, the lateral spines sharp, but not conspicuous. Black; tegulæ yellowish; hair long, that on head (in part), thorax above and abdomen (in part) black; hair of scape and a patch below antennal foveæ slightly yellowish, that of back of head whitish; hairs of legs, sides of thorax, first tergite, apical margin of second segment, and apical margin of third sternite whitish; tarsi piceous; wings brownish hyaline, with a faint purplish sheen; venation brown.

Type locality.—Baguio, Luzon.

Type.—Catalogue No. 23587, United States National Museum.

Described from one female received from W. Robinson.

Scolia (Scolia) incerta sp. nov.

This may be the male of *Scolia luzonensis* Rohwer.

Male.—Length, 18 millimeters; length of anterior wing, 17 millimeters; length of antennæ, about 10 millimeters. Head of normal size; clypeus convex, basally with a few large punctures, the anterior margin truncate; area between the antennæ closely punctured and with a small inconspicuous tubercle; frons shining, sparsely punctured, with a transverse median depression which is angulate medianly to meet the narrow depressed area in front of anterior ocellus; vertex and occiput shining, practically impunctate; postocellar line longer than the ocellocular line; antennæ longer than head and thorax, scape shining, punctured; flagellum opaque, granular, the third joint slightly longer than fourth, apical joint slightly curved, obliquely truncate apically and somewhat longer than the preceding; thorax shining, sparsely punctured; calcaria yellowish, the longer one on the hind tibia more than half as long as basitarsus; abdomen shining, sparsely punctured; first segment subcampanulate,

longer than the second, pygidium and hypopygidium triangular apically. Black, thorax dorsally with a faint bluish reflection, basal tergites cœruleous; tegulæ ferruginous; clypeus except margins, mandibles, line on pronotum laterally (interrupted in type and wanting in one paratype), anterior coxæ beneath, femora, and the four anterior tibiæ beneath yellowish; clothed with long whitish hair, sides of thorax with whitish pile in addition; wings brownish hyaline with a slightly yellowish reflection; venation brown.

In one paratype the lower inner eye margins are narrowly yellow.

Type locality.—Mount Maquiling, Laguna, Luzon.

Type.—Catalogue No. 23588, United States National Museum.

LUZON, Laguna Province, Mount Maquiling (*Baker 4962*) 1 male (type), (*Baker 3190*) 1 male: Bataan Province, Lamao (*C. V. Piper*).

Genus LIACOS Guérin

This genus, which in habitus closely resembles *Scolia*, is represented by one species.

Liacos (Triliacos) analis (Fabricius).

A medium-sized black species with the two apical segments densely clothed with reddish hair. Wings blackish with a faint violaceous reflection basally.

LUZON, Laguna Province, Los Baños (*Baker*) 2 females; Mount Maquiling (*Baker 1541*) 2 males: Bataan Province, Lamao (*C. V. Piper*) 1 male, (*C. R. Jones*) 1 male, under Bureau of Agriculture accession No. 849.

Genus CAMPSOMERIS Lepeletier

All the species of this genus which occur in or have been reported from the Islands belong to the subgenus *Campsomeris* and have only two closed cubital cells. In this genus there is a marked antigeny, and therefore it is very difficult to associate the sexes. To add to this difficulty the species have not been fully described, thus always leaving some doubt as to the correctness of the identification. It seems to me that when more material from the Oriental Region has been studied additional species will have to be described and that some of the forms which are at present treated as unnamed varieties will be found to be sufficiently distinct to deserve names.

The following key includes only species represented in the Philippine material before me, omitting the species *Campso-*

meris grossa (Fabricius) and *C. lindenii* Lepeletier which have been reported from the Islands.

Key to the Philippine species of Campsomeris.

1. Females .... 2.
   Males .... 6.
2. Abdomen, including hair, entirely black .... 3.
   Abdomen with at least pale hair bands .... 4.
3. Body, including hair, entirely black .... C. reticulata (Cameron).
   Body black, hair of pronotum and back of head ferruginous; hair of front of head whitish .... C. aureicollis Lepeletier.
4. Abdomen black, with whitish hair bands on each segment; hair of thorax white; wings hyaline, distinctly darker apically. C. annulata (Fabricius).
   Abdomen with apical margins of tergites yellow .... 5.
5. Hair of head, thorax, and femora reddish .... C. aurulenta (Smith).
   Hair of head, thorax, and femora whitish .... C. aurulenta variety.
6. Body entirely black .... 7.
   At least yellow markings on abdomen .... 8.
7. Dorsal surface of propodeum with dense sericeous pile; abdomen distinctly purplish; wings slightly paler .... C. luctuosa (Smith).
   Dorsal surface of propodeum without dense sericeous pile; abdomen bluish .... C. reticulata (Cameron).
8. Wings blackish; hair (not pile) of thorax black; yellow of abdomen reduced to elongate spots on second and third tergites. C. luctuosa (Smith).
   Wings hyaline to brownish; hair of thorax pale; yellow of abdomen forming bands .... 9.
9. Markings yellowish; wings distinctly yellowish; pubescence of thorax yellowish .... C. aurulenta (Smith).
   Markings whitish; wings dusky hyaline; pubescence of thorax gray.. 10.
10. Abdominal bands broad, that of the second (also third) with a U- or V-shaped emargination medially; clypeus black, yellow at sides. C. annulata (Fabricius).
    Abdominal bands narrow, that on the second (and third less distinctly) dilated at the sides; clypeus yellow, with a small black spot medially .... C. species?

Campsomeris (Campsomeris) luctuosa (Smith).

A male from Mindanao collected by Miss Ludlow and one from Mount Maquiling, Laguna, Luzon, collected by C. F. Baker. The specimen from Mindanao has narrow, elongate spots on sides of second and third tergites.

Campsomeris (Campsomeris) reticulata (Cameron).

LUZON, Mount Banahao (*Baker 2727, 6910*) males: Bataan Province, Lamao, 1911 (*C. V. Piper*) female. PANAY, Antique Province, Culasi, June, 1918 (*McGregor*) female. MINDANAO, Davao (*Baker 6909*) male: Misamis Province, Cagayan (*Baker 3796*) male.

Campsomeris (Campsomeris) aureicollis Lepeletier.

All of the Philippine specimens before me have the hair of the anterior part of the thorax reddish, and for the time being, at least, it seems advisable to use the name *aureicollis* as a specific one. Ashmead in 1904[1] added the name *albicollis* to the list of Philippine species, but as none of the forms have the hair of the collar pale the name *albicollis* should be removed until specimens of this variety are collected in the Islands.

LUZON, Bulacan Province, Baliuag (*B. Arce*), Bureau of Agriculture accession No. 1590: Laguna Province, Mount Maquiling (*Baker*): Manila, July 14, 1901. PANAY, Antique Province, Culasi, June, 1918 (*McGregor*). MINDANAO, May, 1911 (*C. V. Piper*); Dapitan (*Baker 3187*). All females.

Campsomeris (Campsomeris) species?

A number of males, which run to *Campsomeris grossa* in Bingham's key, are much smaller and represent a species which until further study cannot be identified. They may be the male of the female considered as a variety of *aurulenta*.

LUZON, Mountain Province, Baguio (*Baker*): Laguna Province, Los Baños (*Baker*); Mount Maquiling (*Baker*); Mount Banahao (*Baker 4961*). MINDANAO, Davao (*Baker 6908*). All males.

Campsomeris (Campsomeris) annulata (Fabricius).

LUZON, Pangasinan Province, Rosales (*C. R. Jones*), Bureau of Agriculture accession Nos. 379, 380: Laguna Province, Los Baños (*Baker 1431*) male. PANAY, Antique Province, Culasi, June, 1918 (*McGregor*). LEYTE, Tacloban (*Baker 3794*) male. MINDANAO, Iligan (*Baker*) female; Davao (*Baker 6912*) female, male; Cagayan (*Baker 3795*) male.

Campsomeris (Campsomeris) aurulenta (Smith).

This species is evidently allied to *Campsomeris iris* Lepeletier where both the female and male run in Bingham's key to the species of British India.

LUZON, Mountain Province, Baguio (*W. Robinson, C. V. Piper*) females: Bataan Province, Lamao (*C. R. Jones*), Bureau of Agriculture accession No. 1750; Laguna Province, Los Baños (*Baker 522, 1834*) female, male; Mount Maquiling (*Baker 1835, 1363*) female, male; Mount Banahao (*Baker*) male. PANAY,

[1] Proc. U. S. Nat. Mus. 28 (1905) 152.

Antique Province, Culasi (*McGregor*) female, male. MINDANAO, Davao (*Baker*) male.

Campsomeris (Campsomeris) aurulenta Smith variety.

A single female from Baguio, Benguet (*Baker*) is smaller than the typical form and has the hair of the head, thorax, and femora whitish and much sparser. The abdominal bands are somewhat broader, that of the third segment being broadly produced medianly and with a wide angulate emargination. It may be that more material will make it desirable to name this form.

Campsomeris (Campsomeris) lindenii Lepeletier.

This species, which has usually been considered as a synonym of *Campsomeris quadrifasciata* (Fabricius), has been reported from the Islands by Ashmead. It is not represented in any of the material I have seen from there, and the following characters are taken from the description by Bingham in the Fauna of British India:

Female.—Length, 17 to 22 millimeters. Head and thorax sparsely punctured, disk of mesonotum smooth; black, pubescence fulvous to white; wings flavo-hyaline, with a fuscous spot at apex.

Male.—Length, 17 to 22 millimeters. Black; apical margin of clypeus, posterior margin of pronotum, two spots on the scutellum, and transverse fasciæ on the posterior margins of the first four or five tergites yellow; abdominal fasciæ emarginate anteriorly; wings light flavo-hyaline.

Campsomeris (Campsomeris) grossa Fabricius.

This species has been recorded from the Islands but is not in the collections received from there. The female is 25 to 30 millimeters long; black with the pubescence on the head and thorax fuscous, the abdomen with narrow, whitish hair bands. The wings are fusco-hyaline. The male is about 23 millimeters long, with broad transverse bands on the apical margins of the first four tergites yellow; the clypeus is black except for the narrow apical margin and a median spot which are yellow.

Subfamily ELIDINÆ

Only one representative of this subfamily is known from the Islands. The subfamily is readily separated from the Scoliinæ by the cleft claws; the entire (or nearly entire) eyes; the pres-

ence of a single spine, which curves dorsally, at the end of the male abdomen; the two calcaria on the intermediate tibia; the simple tongue; and the characteristic habitus. Many of the species of this subfamily lack the long hair that is characteristic of the Scoliinæ.

Elis (Mesa) tricolor longiceps Turner.

The black thorax and abdomen, red head, and dark wings make it very easy to recognize this striking species.

The females agree exactly with Turner's description of the subspecies, and the males differ from his description of *Mesa crassepunctata* as follows: Head distinctly narrowed behind the eyes; pronotum without obscure transverse striæ, but polished and very sparsely punctured; first tergite longer than the second; abscissa of radius not one-fourth shorter than the third; first recurrent received by the second cubital just before the middle; length, 16 millimeters. The males may have been described by Bingham under the name *Myzine dimidiaticornis*, but the second abscissa of the radius is hardly as long as the third.

LUZON, Mountain Province, Baguio (*W. Robinson*) 1 male, (*Baker*) 1 male: Laguna Province, Mount Maquiling (*Baker*) 2 females.

HIGHER BASIDIOMYCETES FROM THE PHILIPPINES AND THEIR HOSTS, V

By Otto A. Reinking

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Numbers I to IV of this series, on Higher Basidiomycetes from the Philippines and their hosts, show that a large amount of the destruction to forest trees and construction timber is due to fungi. Heretofore, the general belief has been that termites and other insects caused the greatest damage to woods in the Malay Archipelago. Fungi are widespread and are continually working under a variety of conditions. The destruction caused by them is greatest in damp situations and is particularly severe during the rainy season. The ravages of termites, on the other hand, occur only under certain conditions and in definite localities. According to the published lists, individual hosts may be attacked by at least ten different fungi. The damage done to certain structural timbers has been great. The proper kinds of wood to be used for building purposes will consequently depend upon the locality and the use to which they are to be put. As an example, guijo, *Shorea guiso* (Blanco) Blume, because it is attacked by a variety of fungi, should not be used for planking on a bridge which is exposed to rain and to high moisture conditions. Molave, *Vitex parviflora* Juss., is much better for this purpose, as under the same conditions it is not so severely invaded by fungi. It seems probable, because of this fungus attack, that a preservative treatment of all woods used in exposed places would be beneficial.

The following list of fungi is a continuation of the identifications of the higher Basidiomycetes collected on Mount Maquiling, in the vicinity of Los Baños, Laguna Province, Luzon, and in Mindanao. The collections have been made either by me or by students under my direction. I am indebted to Messrs. E. E. Schneider, J. M. Pascual, A. Barros, and L. Adona of the Bureau of Forestry for wood identifications. The majority of the determinations of fungi given in this list were made by C. G. Lloyd, of Cincinnati, Ohio. The species of fungi are

grouped according to the classification of Engler and Prantl, with the host and the collector under each. The numbers refer to the College of Agriculture fungus herbarium.

AURICULARIACEAE

AURICULARIA Bulliard

AURICULARIA AURICULA-JUDAE (Linn.) Schroet.

Annona muricata Linn., college ground, Los Baños, *Collado 5256*, on dead branches.

Annona reticulata Linn., college farm, Los Baños, *Reinking 6400*, on dead branches.

Artocarpus sp., Mount Maquiling, *Soriano 5616*, on dead branches.

Bixa orellana Linn., Mount Maquiling, *Reinking 3928*, on dead branches.

Clerodendron minahassae Teysm. et Binn., Mount Maquiling, *Reinking 4078*, on dead branches.

Ficus sp., Mount Maquiling, *Paulino 5671*, on decaying wood.

Gliricidia sepium (Jacq.) Steud., Mount Maquiling, *Reinking 6254*, on decaying wood.

Hibiscus sp., Mount Maquiling, *Reinking 4297*, on dead twigs.

Jatropha curcas Linn., Mount Maquiling, *Reinking 4283*, on dead branches.

Lansium domesticum Correa, Mount Maquiling, *Sulit 5089*, on dead branches.

Leucaena glauca Benth., Mount Maquiling, *Reinking 6427*, on dead branches.

Mangifera indica Linn., college ground, Los Baños, *Hernandez 957*, on dead branches.

Manihot utilissima Pohl, college ground, Los Baños, *Goco 4072*, on dead wood.

Parameria sp., Mount Maquiling, *Reinking 3915*, on dead branches.

Pterocarpus indicus Willd., Mount Maquiling, *Reinking 6481*, on dead branches.

Streblus asper Lour., Mount Maquiling, *Reinking 4417*, on dead twigs.

Strychnos nux-vomica Linn., Mount Maquiling, *Reinking 6448*, on dead branches.

Triumfetta bartramia Linn., Mount Maquiling, *Reinking 3951*, on dead branches.

AURICULARIA BRASILIENSIS Fr.

Prosopis vidaliana Naves, Mount Maquiling, *Reinking 6494*, on dead branches.

AURICULARIA CORNEA Ehrenb.

Aglaia sp., Mount Maquiling, *Reinking 3923*, on dead branches.

Albizzia acle (Blanco) Merr., Mount Maquiling, *Reinking 4218*, on dead twigs.

Aleurites moluccana (Linn.) Willd., Mount Maquiling, *Pañganiban 5130*, on dead branches.

Allaeanthus luzonicus (Blanco) F.-Vill., Mount Maquiling, *Reinking 4279*, on dead branches.

Annona muricata Linn., Los Baños, *Reinking 3779*, on dead wood.

Annona reticulata Linn., college ground, Los Baños, *Reinking 4232*, on dead twigs.

Clerodendron minahassae Teysm. et Binn., Mount Maquiling, *Reinking 4340*, on dead twigs.

Eriobotrya japonica Lindl., Mount Maquiling, *Reinking 6163*, on dead branches.

Erythrina fusca Lour., college ground, *Reinking 4402*, on dead twigs.

Ficus hauili Blanco, Mount Maquiling, *Reinking 4425*, on dead twigs.

Jatropha curcas Linn., Mount Maquiling, *Reinking 4097*, on dead wood.

Melochia arborea Blanco, Mount Maquiling, *Reinking 4236*, on dead twigs.

Mussaenda philippica Rich, Mount Maquiling, *Reinking 4438*, on dead twigs.

Psidium guajava Linn., college ground, Los Baños, *Reinking 4021*, on dead wood.

Pterocarpus echinatus Pers., Mount Maquiling, *Reinking 4292*, on dead branches.

Sapindus saponaria Blanco, Mount Maquiling, *Reinking 4247*, on dead twigs.

Solanum grandiflorum Ruiz et Pav., Mount Maquiling, *Reinking 4322*, on dead twigs.

Solanum verbascifolium Linn., Los Baños, *Reinking 3766*, on dead wood.

Streblus asper Lour., Los Baños, *Reinking 3772,* on dead wood.

Tecoma stans (Linn.) Juss., Mount Maquiling, *Reinking 6441,* on dead branches.

Theobroma cacao Linn., Los Baños, *Reyes 3907,* on dead branches.

Trema amboinensis (Willd.) Blume, Mount Maquiling, *Reinking 4098,* on dead wood.

Urena lobata Linn., Mount Maquiling, *Reinking 4039,* on dead branches.

Voacanga globosa (Blanco) Merr., Mount Maquiling, *Reinking 6498,* on dead branches.

AURICULARIA MOELLERI Lloyd.

Anisoptera sp., Mount Maquiling, *Reinking 3313,* on dead wood.

Ficus sp., Mount Maquiling, *Baybay 3404,* on dead wood.

AURICULARIA POLYTRICHA (Mont.) Sacc.

Annona squamosa Linn., college ground, Los Baños, *Pañganiban 5511,* on dead branches.

Leucaena glauca Benth., Mount Maquiling, *Soriano 5625,* on dead branches.

TREMELLACEAE

TREMELLA Dillenius

TREMELLA sp.

Probably *Ficus* sp., Mount Maquiling, *Cazeñas 3307,* on dead wood.

TREMELLA FUCIFORMIS Berk.

Caesalpinia pulcherrima (Linn.) Sw., Mount Maquiling, *Reinking 6373,* on dead branches.

Shorea guiso (Blanco) Blume, Manila, *Reinking 9701,* on dead wood.

TREMELLA SAMOENSIS Lloyd.

Mount Maquiling, *Reinking 9803,* on dead wood.

DACRYOMYCETACEAE

GUEPINIA Fries

GUEPINIA FISSA Berk.

Cassia siamea Lam., Davao, *Ademesa 6059,* on rotten trunk.

Sapium merrillianum Pax et K. Hoffm., Mount Maquiling, *Marilao 9720,* on dead wood.

Vitex parviflora Juss., Los Baños, *Moncerate 6021,* on railway ties.

GUEPINIA SPATHULATA Schw.

Bambusa sp., Mount Maquiling, *Reinking 5069*, on dead culms.

Gliricidia sepium (Jacq.) Steud., Mount Maquiling, *Reinking 6253*, on decaying wood.

Leucaena glauca Benth., Mount Maquiling, *Reinking 6266*, on dead branches.

THELEPHORACEAE

CORTICIUM Persoon

CORTICIUM sp.

Bambusa sp., college campus, Los Baños, *Marquez 3389*, on dead culms.

Gliricidia sepium (Jacq.) Steud., Los Baños, *Fello 9716*, on dead wood.

Leucaena glauca Benth., Mount Maquiling, *Nano 9342*, on dead wood.

Polyalthia sp., Mount Maquiling, *Serrano 9772*, on dead wood.

Shorea guiso (Blanco) Blume, Mount Maquiling, *Ferrer 9765*, on dead wood.

HYMENOCHAETE Léveillé

HYMENOCHAETE ROSEA Lloyd.

Quercus sp., Mount Maquiling, *Marilao 9634*, on dead wood.

STEREUM Persoon

STEREUM sp.

Bambusa sp., Mount Maquiling, *Habaluyas 9620*, on dead culms.

STEREUM AURISCALPIUM Lloyd.

Mount Maquiling, *Reyes 9656*, on the ground.

STEREUM ELEGANS Meyer.

Mount Maquiling, *Sison 9715*, on the ground.

STEREUM FELLOI Lloyd.

Sapium merrillianum Pax et K. Hoffm., Mount Maquiling, *Fello 9738*, on dead wood.

STEREUM INVOLUTUM Kl.

Probably Annonaceae, college campus, Los Baños, *Pañganiban 3356*.

STEREUM NIGROPUS Lloyd.

Ficus sp., Mount Maquiling, *Pañganiban 3379*, on dead wood.

STEREUM OSTREUM Nees.

Probably *Leucaena glauca* Benth., Mount Maquiling, *Mendoza 3396*, on dead wood.

STEREUM PUSILUM Berk.

Los Baños, *Abisamis 9694,* on the ground.

STEREUM SPECTABILE Kl.

Probably *Quercus* sp., San Antonio, Los Baños, *Esguera 375,* on dead wood.

CLADODERRIS Persoon

CLADODERRIS INFUNDIBULIFORMIS Kl.

Ficus sp., Mount Maquiling, *Reyes 749,* on dead wood.

CYPHELLA Fries

CYPHELLA FULVODISCA Cooke.[1]

Ficus sp., Mount Maquiling, *Sanches 9749,* on dead wood.

SOLENIA Hoffman

SOLENIA GLOBOSA Lloyd.

Ficus sp., Mount Maquiling, *Reinking 9784,* on dead wood.

CLAVARIACEAE

PISTILLARIA Fries

PISTILLARIA sp.

Alstonia sp., Mount Maquiling, *Mendoza 3301,* on dead wood.

PTERULA Fries

PTERULA ACICULAE Lloyd.

Ficus sp., Mount Maquiling, *Reinking 3330,* on dead wood.

PTERULA INCISA Lloyd.

Mount Maquiling, *Obias 9687,* on dead wood.

PTERULA MANNII Lloyd.

Mount Maquiling, *Sanches 9795,* on soil.

PTERULA TAXIFORMIS Mont.

Bambusa sp., Los Baños, *Habaluyas 9691,* on dead culms.

LACHNOCLADIUM Léveillé

LACHNOCLADIUM GENICULATUM Lév.

Mount Maquiling, *Sanches 9798,* on dead wood.

HYDNACEAE

PHLEBIA Fries

PHLEBIA REFLEXA Berk.

Zizyphus sp., Mount Maquiling, *Fello 9737,* on dead wood.

[1] Incorrectly spelled as Cyphella fusco-disca Cooke in Reinking, Otto A., Higher Basidiomycetes from the Philippines and their hosts, II, Philip. Journ. Sci. 16 (1920) 170.

IRPEX Fries

IRPEX sp.

Probably *Ficus* sp., college campus, Los Baños, *Reinking 3308*, on dead wood.

IRPEX FLAVUS Kl.

Bambusa vulgaris Schrad., college campus, Los Baños, *Reyes 4137*, on dead culms.

Leucaena glauca Benth., Mount Maquiling, *Sarmiento 5174*, on dead branches.

GRAMMOTHELE Berkeley et Curtis.

GRAMMOTHELE MAPPA Berk.

Ficus sp., Mount Maquiling, *Cazeñas 991*, on dead wood.

POLYPORACEAE

MERULIUS Haller

MERULIUS CONSIMILIS Lloyd.

Bambusa sp., Los Baños, *Habaluyas 9768*, on dead culms.

PORIA Persoon

PORIA sp.

Delonix regia Raf., Mount Maquiling, *Nacion 9777*, on dead wood.

Ficus sp., Mount Maquiling, *Ferrer 9642*, on dead wood.

Leucaena glauca Benth., Mount Maquiling, *Caray 9631*, on dead wood.

Mallotus sp., Mount Maquiling, *Abisamis 9728*, on dead wood.

Parkia timoriana (DC.) Merr., Mount Maquiling, *Bacol 9800*, on dead wood.

Probably *Shorea* sp., college campus, Los Baños, *Baybay 3342*, on dead wood.

PORIA ESPIMILTINA Berk.

Possibly *Shorea* sp., Mount Maquiling, *Sanches 9781*, on dead wood.

PORIA FULIGO Berk.

Mallotus sp., Mount Maquiling, *Rocafort 9751*, on dead wood.

PORIA SETULOSA P. Henn.

Mallotus sp., Mount Maquiling, *Ricafort 9751*, on dead wood.

FOMES Fries

FOMES APPLANATUS Pers.

Anisoptera sp., Kuruan, Zamboanga, *Babao 450*, on decaying wood.

180365——7

Cocos nucifera Linn., Santa Cruz, *Reyes 2955*, on dead trunk.

Dipterocarpus, Mount Banahao, *Reinking 4187*, on decaying wood.

Leucaena glauca Benth., Mount Maquiling, *Ferrér 9713*, on dead branch.

Shorea sp., Zamboanga, *Tecson 456*, on decaying wood.

Tamarindus indica Linn., San Antonio, Los Baños, *Reyes 4130*, on dead trunk.

FOMES CINEREUS Rick.

Los Baños, *Abisamis 9711*, on dead wood.

FOMES GIBBOSUS Nees.

Sandoricum koetjape (Burm. f.) Merr., Santa Cruz, *Reyes 5110*, on dead stump.

FOMES KERMES Berk.

Mount Maquiling, *Caray 9782*, on dead wood.

FOMES LAMAENSIS Murr.

Mount Maquiling, *Malabanan 9802*, on dead wood.

FOMES NIGROLACCATUS Cooke.

Mount Maquiling, *Reyes 9683*, on dead wood.

POLYPORUS Micheli

POLYPORUS ANEBUS Berk.

Mount Maquiling, *Marilao 9636*, on dead wood.

POLYPORUS ANNULATUS Jungh.

Gliricidia sepium (Jacq.) Steud., Los Baños, *Zabella 9712*, on dead wood.

POLYPORUS (GANODERMUS) ASPERULATUS Murr.

Mount Maquiling, *Ferrer 9767*, on the ground.

POLYPORUS CALIGNOSUS Berk.

Possibly Euphorbiaceae, Mount Maquiling, *Libunao 9615*, on dead wood.

Mallotus sp., Mount Maquiling, *Malabanan 9801*, on dead wood.

POLYPORUS CONCHOIDES Mont.

Probably Guttiferae, Mount Maquiling, *Nantes 3395*, on dead wood.

POLYPORUS CYSTIDIOIDES Lloyd.

Mount Maquiling, *Nacion 9669*, on dead wood.

POLYPORUS (or FOMES) GIBBOSUS Nees.

Gliricidia sepium (Jacq.) Steud., Los Baños, *Abisamis 9710*, on dead wood.

POLYPORUS GRAMMOCEPHALUS Berk.

Alstonia sp., Mount Maquiling, *Reinking 3314*, on dead wood.

POLYPORUS LICNOIDES Mont.

Mount Maquiling, *Dadufalsa 9717*, on dead wood.

POLYPORUS MASTOPORUS Lév.

Zizyphus sp., Mount Maquiling, *Collado 9682*, on dead wood.

POLYPORUS OBOVATUS Jungh.

Probably *Alangium* sp., Mount Maquiling, *Malabanan 9610*, on dead wood.

POLYPORUS PERVERSUS Copel.

Probably Rubiaceae, Mount Maquiling, *Reinking 3442*, on dead stem.

POLYPORUS RHINOCEROTIS Cooke.

Mount Maquiling, *Bagui 5119*, on the ground.

POLYPORUS RHIZOPHORAE Reichard.

Los Baños waterfalls, Los Baños, *Serrano 6169*, on dead log.

POLYPORUS RIGIDUS Lév.

Annona squamosa Linn., Santa Cruz, Laguna, *Reyes 6097*, on dead bark.

Bambusa sp., college campus, Los Baños, *Paulino 5669*, on dead culms.

Cordia myxa Linn., Mount Maquiling, *Sarmiento 5656*, on dead branches.

Gliricidia sepium (Jacq.) Steud., college campus, Los Baños, *Bagui 6627*, on old post.

Mangifera indica Linn., Davao, Davao, *Ademesa 6063*, on rotten trunk.

Shorea guiso (Blanco) Blume, Mount Maquiling, *Ferrer 9765*, on dead wood.

Vitex sp., Mount Maquiling, *Reinking 6623*, on dead branches.

POLYPORUS RUGOSUS Nees.

Mount Maquiling, *Reinking 6087*, on soil.

POLYPORUS SEMILACCATUS Berk.

Celtis sp., Mount Maquiling, *Nantes 661*, on dead wood.

Lagerstroemia speciosa (Linn.) Pers., Mount Maquiling, *Manza 6598*, on dead wood.

POLYPORUS TABACINUS Mont.

Tabernaemontana pandacaqui Poir., Mount Maquiling, *Reinking 6133*, on dead branches.

POLYPORUS (GANODERMUS) WILLIAMSIANUS Murr.

Possibly Burseraceae, Mount Maquiling, *Malabanan 9698*, on dead wood.

POLYPORUS ZONALIS Berk.

Bambusa sp., Mount Maquiling, *Bagui 5107*, on dead stump.

Bambusa spinosa Roxb. (*B. blumeana* Schultes), Los Baños, *Ocfemia 4123*, on old bamboo posts.

Ficus sp., Mount Maquiling, *Reinking 3432*, on dead wood.

Leucaena glauca Benth., Mount Maquiling, *Pañganiban 5122*, on dead stump.

Mallotus sp., college campus, Los Baños, *Navera 1065*, on dead wood.

Palmae, college campus, Los Baños, *Divinagracia 3390*, on dead stem.

Polyalthia sp., Mount Maquiling, *Libunao 9769*, on dead wood.

Pterocarpus sp., Mount Maquiling, *Aquino 6636*, on dead branches.

Probably Rubiaceae, Mount Maquiling, *Baybay 3372*, on dead stem.

POLYSTICTUS Fries

POLYSTICTUS AFFINIS Nees.

Mallotus sp., Mount Maquiling, *Reinking 9679*, on dead wood.

POLYSTICTUS CERVINO-GILVUS Jungh.

Probably Burseraceae, Mount Maquiling, *Baybay 979*, on dead wood.

POLYSTICTUS CRYPTOMENIAE P. Henn.

Ficus sp., Mount Maquiling, *Baybay 751*, on dead wood.

Pometia pinnata Forst., Mount Maquiling, *Mendoza 3385*, on dead wood.

POLYSTICTUS FLAVIDUS Jungh.

Mallotus sp., Mount Maquiling, *Nacion 9780*, on dead wood.

POLYSTICTUS (or IRPEX) FLAVUS Jungh.

Acacia farnesiana (Linn.) Willd., Mount Maquiling, *Peña 5684*, on dead branches.

Bauhinia tomentosa Linn., Mount Maquiling, *Reinking 4307*, on dead twigs.

Citrus sp., Lamao experiment station, Bataan, *Reinking 5898.*

Cordia myxa Linn., Los Baños, *Babao 9793*, on dead wood.

Euphorbiaceae, Mount Maquiling, *Corrales 6617*, on dead log.

Gliricidia sepium (Jacq.) Steud., Mount Maquiling, *Reinking 6248*, on dead branches.

Mangifera indica Linn., college ground, Los Baños, *David 6109*, on dead branches.

Tamarindus indica Linn., college ground, Los Baños, *Cuzner 6475*, on dead log.

Vitex sp., Mount Maquiling, *Piquing 6567*, on dead branches.

POLYSTICTUS MELEAGRIS Berk.

Koordersiodendron pinnatum (Blanco) Merr., Mount Maquiling, *Nano 9599*, on dead wood.

POLYSTICTUS MEYENII Kl.

Aleurites moluccana (Linn.) Willd., Mount Maquiling, *Collado 5219*, on dead branches.

Possibly *Vitex* sp., Mount Maquiling, *Sison 9766*, on dead wood.

POLYSTICTUS OCCIDENTALIS Kl.

Albizzia saponaria Blume, Cabantian, Davao, *Ademesa 6042*, on dead trunk.

Gliricidia sepium (Jacq.) Steud., Mount Maquiling, *Collado 5217*, on dead branches.

Mangifera indica Linn., Los Baños, *Reyes 3910*, on dead branches.

Pithecolobium sp., Mount Maquiling, *Reinking 2970*, on dead wood.

Tamarindus indica Linn., Mount Maquiling, *Paulino 5274*, on dead wood.

POLYSTICTUS PERSOONII Mont.

Mount Maquiling, *Malabanan 9626*, on dead wood.

POLYSTICTUS SANGUINEUS Linn.

Annonaceae, Los Baños, *Piquing 5961*, on railway ties.

Bambusa sp., Mount Maquiling, *Lacson 5619*, on dead culms.

Bambusa spinosa Roxb. (*B. blumeana* Schultes), Anos, Los Baños, *Collado 5155*, on dead culms.

Cassia siamea Lam., Davao, Davao, *Ademesa 6044*, on dead branches.

Diospyros discolor Willd., college campus, Los Baños, *Reinking 4136,* on old flagpole.

Dipterocarpus sp., college campus, Los Baños, *Morada 5928,* on board.

Myristica sp., Mount Maquiling, *Mariano 9744,* on dead wood.

Neonauclea sp., Pangasinan, *Soriano 6020,* on railway ties.

Parashorea plicata Brandis, college campus, Los Baños, *Cuzner 3663,* on old board.

Pterocarpus sp., college campus, Los Baños, *Pañganiban 6650,* on old board.

Shorea philippinensis Brandis, Manila, *Barros 10499,* on piling.

POLYSTICTUS SETULOSUS (P. Henn.) Lloyd.

Ficus sp., college campus, Los Baños, *Pañganiban 3397,* on dead wood.

POLYSTICTUS SPADICEUS Bres.

Areca catechu Linn., Los Baños, *Reyes 4135,* on dead stem.

POLYSTICTUS STYRACICOLA Lloyd.

Mount Maquiling, *Malabanan 9635,* on dead wood.

POLYSTICTUS TABACINUS Mont.

Probably *Dipterocarpus* sp. or *Anisoptera* sp., Mount Maquiling, *Cazeñas 610,* on dead wood.

POLYSTICTUS VERSATILIS Berk.

Eucalyptus sp., Los Baños, *Miñano 6013,* on railway ties.

Hopea sp., Los Baños, *Iang 6030,* on railway ties.

Intsia bijuga O. Ktze., Los Baños, *Reinking 5627,* on railway ties.

Shorea guiso (Blanco) Blume, Los Baños, *Limbo 6008,* on railway ties.

Terminalia comintana (Blanco) Merr., Los Baños, *Goco 5951,* on railway ties.

Vatica sp., Los Baños, *Corrales 6027,* on railway ties.

POLYSTICTUS XANTHOPUS Fr.

Psidium guajava Linn., college ground, Los Baños, *Collado 5461,* on decaying branch.

Probably *Shorea* sp., Mount Maquiling, *Corcino 9794,* on dead wood.

POLYSTICTUS ZELANICUS Berk.

Probably *Celtis* sp., college campus, Los Baños, *Reyes 2951,* on dead wood.

TRAMETES Fries

TRAMETES ACUTA Lév.

Bambusa sp., college campus, Los Baños, *Reinking 3428*, on dead culms.

Cocos nucifera Linn., Los Baños, *Reyes 3597*, on dead trunk.

TRAMETES MEYENII Kl.

Cordia myxa Linn., Mount Maquiling, *Novero 6009*, on dead branches.

Intsia bijuga O. Ktze., Mount Maquiling, *Catalan 5681*, on decaying timber.

Leucaena glauca Benth., Mount Maquiling, *Reinking 3443*, on dead wood.

TRAMETES PERSOONII Mont.

Euphorbiaceae, Mount Maquiling, *Corrales 6614*, on dead log.

Gliricidia sepium (Jacq.) Steud., Los Baños, *Reyes 5164*, on dead trunk.

Pterocarpus indicus Willd., Mount Maquiling, *Sarmiento 5183*, on dead log.

Theobroma cacao Linn., Los Baños, *Reyes 4143*, on dead branches.

TRAMETES SERPENS Fr.

Aleurites sp., Mount Maquiling, *Reinking 9753*, on dead wood.

DAEDALEA Persoon

DAEDALEA FLAVIDA Lév.

Bambusa sp., Mount Maquiling, *Bagui 5231*, on dead stump.

Lansium domesticum Correa, Los Baños, *Reyes 3578*, on decaying wood.

Parashorea plicata Brandis, college campus, Los Baños, *Cuzner 3664*, on old board.

Terminalia comintana (Blanco) Merr., college campus, Los Baños, *Collado 2996*, on old board.

LENZITES Fries

LENZITES ACUTA Berk.

Zea mays Linn., Los Baños, *Ocfemia 3938*, on dried ears.

LENZITES DEPLANATA Klotz.

Mount Maquiling, *Manza 6074*, on dead branches.

LENZITES REPANDA Pers.

Acacia farnesiana (Linn.) Willd., Mount Maquiling, *Mangonon 5223*, on dead branches.

Bambusa spinosa Roxb. (*B. blumeana* Schultes), college campus, Los Baños, *Reyes 4138*, on dead culms.

Celtis sp., Mount Maquiling, *Catalan 5664*, on decayed log.

Probably Euphorbiaceae, college campus, Los Baños, *Reyes 2937*, on dead wood.

Gliricidia sepium (Jacq.) Steud., Mount Maquiling, *Sulit 5617*, on dead trunk.

Leucaena glauca Benth., Mount Maquiling, *Reinking 6265*, on dead branches.

Parashorea plicata Brandis, Sirio, Lami, Zamboanga, *Tecson 457*, on decaying wood.

Parkia timoriana (DC.) Merr., Mount Maquiling, *Piquing 5577*, on dead log.

Persea gratissima Gaertn., Mount Maquiling, *Ocfemia 5523*, on decaying branches.

Pithecolobium sp., Mount Maquiling, *Reyes 2972*, on dead wood.

Prosopis vidaliana Naves, Mount Maquiling, *Reinking 6496*, on dead branches.

Tamarindus indica Linn., college campus, Los Baños, *Collado 5140*, on dead branches.

LENZITES STRIATA Swartz.

Pterocarpus indicus Willd., college campus, Los Baños, *Reinking 6477*, on painted board.

Strombosia philippinensis Rolfe, Los Baños, *Aquino 6010*, on railway ties.

HEXAGONA Fries

HEXAGONA ALBIDA Berk.

Probably *Celtis* sp., Mount Maquiling, *Santos 3454*, on dead wood.

Euphorbiaceae, Mount Maquiling, *Corrales 6616*, on dead log.

HEXAGONA TENUIS Hooker.

Rapanea philippinensis (A. DC.) Mey., Mount Maquiling, *Reinking 6513*, on dead branches.

FAVOLUS Fries

FAVOLUS ALBUS Lloyd.

Ficus sp., Mount Maquiling, *Catalan 5682*, on living stump.

FAVOLUS BRASILIENSIS Fr.

Mount Maquiling, *Reyes 9690*, on dead wood.

FAVOLUS PLATYPORUS Berk.

Alstonia sp., Mount Maquiling, *Cazeñas 3423*, on dead wood.

FAVOLUS SPATHULATUS Jungh.

Diplodiscus paniculatus Turcz., Mount Maquiling, *Nacion 9665*, on dead wood.

Ophioliaceae, Mount Maquiling, *Collado 9681*, on dead wood.

FAVOLUS TENUISSIMUS Lév.

Mount Maquiling, *Sarmiento 5622*, on dead branches.

AGARICACEAE

CAMPANELLA P. Hennings

CAMPANELLA CUCULLATA Jungh.

Bambusa sp., Los Baños, *Reyes 9605*, on dead culm.

CANTHARELLA (Adans.) Linnaeus

CANTHARELLUS BUCCINALIS Mont.

Ficus sp., Mount Maquiling, *Habaluyas 9721*, on dead wood.

CANTHARELLUS INFUNDIBULIFORMIS Berk.

Ficus sp., college campus, Los Baños, *Reinking 3452*, on dead wood.

SCHIZOPHYLLUM Fries

SCHIZOPHYLLUM COMMUNE Fr.

Acacia farnesiana (Linn.) Willd., Mount Maquiling, *Catalan 5588*, on dead branches.

Aleurites moluccana (Linn.) Willd., Mount Maquiling, *Peña 5090*, on dead branches.

Anacardiaceae, college campus, Los Baños, *Pereira 5925*, on post of house.

Annona glabra Linn., college ground, Los Baños, *Corrales 5479*, on dead wood.

Bambusa sp., college campus, Los Baños, *Reinking 6648*, on dead culms.

Bambusa spinosa Roxb. (*B. blumeana* Schultes), college ground, Los Baños, *Reinking 6078*, on dead culms.

Probably Burseraceae, college campus, Los Baños, *Reinking 3409*, on dead wood.

Calamus sp., Mount Maquiling, *Ocfemia 5678*, on dead culms.

Cassia sp., Mount Maquiling, *Collado 4466*, on dead roots.

Celtis sp., Mount Maquiling, *Catalan 5664*, on decayed log.

Cordia myxa Linn., Mount Maquiling, *Salva Cruz 5191*, on dead bark.

Ficus sp., Mount Maquiling, *Reinking 6125*, on dead branches.

Ficus nota (Blanco) Merr., Mount Maquiling, *Manza 5249*, on dead branches.

Intsia bijuga O. Ktze., Manila, *Adona 10497*, on railway ties.

Probably *Koordersiodendron pinnatum* (Blanco) Merr., college campus, Los Baños, *Reyes 2935*, on dead wood.

Morus alba Linn., college farm, Los Baños, *Palo 3813*, on dead branches.

Persea gratissima Gaertn., Mount Maquiling, *Ocfemia 5532*, on dead branches.

Pterocarpus indicus Willd., Manila, *Adona 10495*, on railway ties.

Shorea mindanensis Desp., Manila, *Barros 10498*, on piling.

Spondias lutea Linn., Mount Maquiling, *Ocfemia 5476*, on dead branches.

LENTINUS Fries

LENTINUS sp.

Myristica sp., Mount Maquiling, *Marilao 9752*, on dead wood.

LENTINUS BADIUS Berk.

Bambusa sp., Los Baños, *Collado 9714*, on dead stump.

LENTINUS CRINITUS Swartz.

Barringtonia sp., Mount Maquiling, *Abisamis 9677*, on dead wood.

LENTINUS STRIGOSUS Schw.

Mallotus sp., Mount Maquiling, *Corcino 9662*, on dead wood.

Pterocymbium tinctorium (Blanco) Merr., Mount Maquiling, *Dadufalsa 9725*, on dead wood.

PANUS Fries

PANUS CLADOPHORA Berk.

Mount Maquiling, *Aquino 6632*, on dead log.

PLEUROTUS Fries

PLEUROTUS sp.

Polyscias nodosa (Blume) Seem., Los Baños, *Abisamis 9770*, on dead stem.

NIDULARIACEAE

CYATHUS Haller

CYATHUS MONTAGNEI Tul.

Agathis alba (Lam.) Foxw., Mount Maquiling, *Reinking 9700*, on dead wood.

Annonaceae, Mount Maquiling, *Habaluyas 9622*, on dead wood.

Gliricidia sepium (Jacq.) Steud., Los Baños, *Zabella 9756*, on dead wood.

CYATHUS PLICATULUS Poep.

Bambusa sp., Mount Maquiling, *Reyes 9646*, on dead culm.

Probably *Polyalthia* sp., college campus, Los Baños, *Reinking 3445*, on dead wood.

SCLERODERMATACEAE

SCLERODERMA Persoon

SCLERODERMA CEPA Pers.

College campus, Los Baños, *Reinking 6069*, on nest of termites.

FUNGI LISTED ACCORDING TO HOSTS

ACACIA FARNESIANA (Linn.) Willd.
Lenzites repanda Pers., on dead branches.
Polystictus (or *Irpex*) *flavus* Jungh., on dead branches.
Schizophyllum commune Fr., on dead branches.

AGATHIS ALBA (Lam.) Foxw.
Cyathus montagnei Tul., on dead wood.

AGLAIA sp.
Auricularia cornea Ehrenb., on dead branches.

ALANGIUM sp.
Polyporus obovatus Jungh., on dead wood.

ALBIZZIA ACLE (Blanco) Merr., on dead twigs.
Auricularia cornea Ehrenb., on dead twigs.

ALBIZZIA SAPONARIA Blume.
Polystictus occidentalis Kl., on dead trunk.

ALEURITES sp.
Trametes serpens Fr., on dead wood.

ALEURITES MOLUCCANA (Linn.) Willd.
Auricularia cornea Ehrenb., on dead branches.
Polystictus meyenii Kl., on dead branches.
Schizophyllum commune Fr., on dead branches.

ALLAEANTHUS LUZONICUS (Blanco) F.-Vill.
Auricularia cornea Ehrenb., on dead branches.

ALSTONIA sp.
Favolus platyporus Berk., on dead wood.
Pistillaria sp., on dead wood.
Polyporus grammocephalus Berk., on dead wood.

ANACARDIACEAE.
Schizophyllum commune Fr., on post of house.

ANISOPTERA sp.
Auricularia moelleri Lloyd, on dead wood.
Fomes applanatus Pers., on decaying wood.

ANNONA GLABRA Linn.
Schizophyllum commune Fr., on dead wood.

ANNONA MURICATA Linn.
Auricularia auricula-judae (Linn.) Schroet., on dead branches.
Auricularia cornea Ehrenb., on dead twigs.

ANNONA RETICULATA Linn.
Auricularia auricula-judae (Linn.) Schroet., on dead branches.
Auricularia cornea Ehrenb., on dead twigs.

ANNONA SQUAMOSA Linn.
Auricularia polytricha (Mont.) Sacc., on dead branches.
Polyporus rigidus Lév., on dead bark.

ANNONACEAE.
Cyathus montagnei Tul., on dead wood.
Polystictus sanguineus Linn., on railway ties.
Stereum involutum Kl., on dead wood.

ARECA CATECHU Linn.
Polystictus spadiceus Bres., on dead stem.

ARTOCARPUS sp.
Auricularia auricula-judae (Linn.) Schroet., on dead branches.

BAMBUSA sp.
Campanella cucullata Jungh., on dead culms.
Corticium sp., on dead culms.
Cyathus plicatulus Poep., on dead culms.
Daedalea flavida Lév., on dead stump.
Gucpinia spathularia Schw., on dead culms.
Lentinus badius Berk., on dead stump.
Merulius consimilis Lloyd, on dead culms.
Polyporus rigidus Lév., on dead culms.
Polyporus zonalis Berk., on dead stump.
Polystictus sanguineus Linn., on dead culms.
Pterula taxiformis Mont., on dead culms.
Schizophyllum commune Fr., on dead culms.
Stereum sp., on dead culms.
Trametes acuta Lév., on dead culms.

BAMBUSA SPINOSA Roxb. (*B. blumeana* Schultes).
Lenzites repanda Pers., on dead culms.
Polyporus zonalis Berk., on old bamboo posts.
Polystictus sanguineus Linn., on dead culms.
Schizophyllum commune Fr., on dead culms.

BAMBUSA VULGARIS Schrad.
Irpex flavus Kl., on dead culms.

BARRINGTONIA sp.
Lentinus crinitus Swartz, on dead wood.

BAUHINIA TOMENTOSA Linn.
Polystictus flavus Jungh., on dead twigs.

BIXA ORELLANA Linn.
Auricularia auricula-judae (Linn.) Schroet., on dead branches.

BURSERACEAE.
Polyporus (Ganodermus) williamsianus Murr., on dead wood.
Polystictus cervino-gilvus Jungh., on dead wood.
Schizophyllum commune Fr., on dead wood.

CAELSALPINIA PULCHERRIMA (Linn.) Sw.
Tremella fuciformis Berk., on dead branches.

CALAMUS sp.
Schizophyllum commune Fr., on dead stems.

CASSIA sp.
Schizophyllum commune Fr., on dead roots.

CASSIA SIAMEA Lam.
Guepinia fissa Berk., on rotten trunk.
Polystictus sanguineus Linn., on dead branches.

CELTIS sp.
Hexagona albida Berk., on dead wood.
Lenzites repanda Pers., on decayed log.
Polyporus semilaccatus Berk., on dead wood.
Polystictis zelanicus Berk., on dead wood.
Schizophyllum commune Fr., on decayed log.

CITRUS sp.
Polystictus flavus Jungh., on dead branches.

CLERODENDRON MINAHASSAE Teysm. et Binn.
Auricularia auricula-judae (Linn.) Schroet., on dead branches.
Auricularia cornea Ehrenb., on dead twigs.

COCOS NUCIFERA Linn.
Fomes applanatus Pers., on dead trunk.
Trametes acuta Lév., on dead trunk.

CORDIA MYXA Linn.
Polyporus rigidus Lév., on dead branches.
Polystictus flavus Jungh., on dead wood.
Trametes meyenii Kl., on dead branches.
Schizophyllum commune Fr., on dead bark.

DELONIX REGIA Raf.
Poria sp., on dead wood.

DIOSPYROS DISCOLOR Willd.
Polystictus sanguineus Linn., on old flagpole.

DIPLODISCUS PANICULATUS Turcz.
Favolus spatulatus Jungh., on dead wood.

DIPTEROCARPUS sp.
Fomes applanatus Pers., on decaying wood.
Polystictus sanguineus Linn., on board.
Polystictus tabacinus Mont., on dead wood.

ERIOBOTRYA JAPONICA Lindl.
Auricularia cornea Ehrenb., on dead branches.

ERYTHRINA FUSCA Lour.
Auricularia cornea Ehrenb., on dead twigs.

EUCALYPTUS sp.
Polystictus versatilis Berk., on railway ties.

EUPHORBIACEAE.

Hexagona albida Berk., on dead log.
Lenzites repanda Pers., on dead wood.
Polyporus calignosus Berk., on dead wood.
Polystictus flavus Jungh., on dead log.
Trametes persoonii Mont., on dead log.

FICUS sp.

Auricularia auricula-judae (Linn.) Schroet., on decaying wood.
Auricularia moelleri Lloyd, on dead wood.
Cantharellus buccinalis Mont., on dead wood.
Cantharellus infundibuliformis Berk., on dead wood.
Cladoderris infundibuliformis Kl., on dead wood.
Cyphella fulvodisca Cooke, on dead wood.
Favolus albus Lloyd, on living stump.
Grammothele mappa Berk., on dead wood.
Irpex sp., on dead wood.
Polyporus zonalis Berk., on dead wood.
Polystictus cryptomeniae P. Henn., on dead wood.
Polystictus setulosus (P. Henn.) Lloyd, on dead wood.
Poria sp., on dead wood.
Pterula aciculae Lloyd, on dead wood.
Schizophyllum commune Fr., on dead branches.
Solenia globosa Lloyd, on dead wood.
Stereum nigropus Lloyd, on dead wood.
Tremella sp., on dead wood.

FICUS HAUILI Blanco.

Auricularia cornea Ehrenb., on dead twigs.

FICUS NOTA (Blanco) Merr.

Schizophyllum commune Fr., on dead branches.

GLIRICIDIA SEPIUM (Jacq.) Steud.

Auricularia auricula-judae (Linn.) Schroet., on decayed wood.
Corticium sp., on dead wood.
Cyathus montagnei Tul., on dead branches.
Guepinia spathulata Schw., on decaying wood.
Lenzites repanda Pers., on dead trunk.
Polyporus annulatus Jungh., on dead wood.
Polyporus gibbosus Nees, on dead wood.
Polyporus rigidus Lév., on old post.
Polystictus flavus Jungh., on dead branches.
Polystictus occidentalis Kl., on dead branches.
Trametes persoonii Mont., on dead trunk.

GUTTIFERAE.

Polyporus conchoides Mont., on dead wood.

HIBISCUS sp.

Auricularia auricula-judae (Linn.) Schroet., on dead branches.

HOPEA sp.

Polystictus versatilis Berk., on railway ties.

INTSIA BIJUGA O. Ktze.

Polystictus versatilis Berk., on railway ties.
Trametes meyenii Kl., on decaying timber.

JATROPHA CURCAS Linn.
Auricularia auricula-judae (Linn.) Schroet., on dead branches.
Auricularia cornea Ehrenb., on dead wood.

KOORDERSIODENDRON PINNATUM (Blanco) Merr.
Polystictus meleagris Berk., on dead wood.
Schizohpyllum commune Fr., on dead wood.

LAGERSTROEMIA SPECIOSA (Linn.) Pers.
Polyporus semilaccatus Berk., on dead wood.

LANSIUM DOMESTICUM Correa.
Auricularia auricula-judae (Linn.) Schroet., on dead branches.
Daedalea flavida Lév., on decaying wood.

LEUCAENA GLAUCA Benth.
Auricularia auricula-judae (Linn.) Schroet., on dead branches.
Auricularia polytricha (Mont.) Sacc., on dead branches.
Corticium sp., on dead wood.
Fomes applanatus Pers., on dead branches.
Guepinia spathulata Schw., on dead branches.
Irpex flavus Kl., on dead branches.
Lenzites repanda Pers., on dead branches.
Polyporus zonalis Berk., on dead stump.
Poria sp., on dead wood.
Stereum ostreum Nees, on dead wood.
Trametes meyenii Kl., on dead wood.

MALLOTUS sp.
Lentinus strigosus Schw., on dead wood.
Polyporus zonalis Berk., on dead wood.
Polystictus affinis Nees, on dead wood.
Poria sp., on dead wood.
Poria fuligo Berk., on dead wood.
Poria setulosa P. Henn., on dead wood.

MANGIFERA INDICA Linn.
Auricularia auricula-judae (Linn.) Schroet., on dead branches.
Polyporus rigidus Lév., on rotten trunk.
Polystictus flavus Jungh., on dead branches.
Polystictus occidentalis Kl., on dead branches.

MANIHOT UTILISSIMA Pohl.
Auricularia auricula-judae (Linn.) Schroet., on dead branches.

MELOCHIA ARBOREA Blanco.
Auricularia cornea Ehrenb., on dead twigs.

MORUS ALBA Linn.
Schizophyllum commune Fr., on dead branches.

MUSSAENDA PHILIPPICA Rich.
Auricularia cornea Ehrenb., on dead twigs.

MYRISTICA sp.
Lentinus sp., on dead wood.
Polystictus sanguineus Linn., on dead wood.

NEONAUCLEA sp.
Polystictus sanguineus Linn., on railway ties.

OPHIOLIACEAE.
Favolus spathulatus Jungh., on dead wood.

PALMAE.
Polyporus zonalis Berk., on dead stem.

PARAMERIA sp.
Auricularia auricula-judae (Linn.) Schroet., on dead branches.

PARASHOREA PLICATA Brandis.
Daedalea flavida Lév., on old board.
Lenzites repanda Pers., on decayed wood.
Polystictus sanguineus Linn., old board.

PARKIA TIMORIANA (DC.) Merr.
Lenzites repanda Pers., on dead log.
Poria sp., on dead wood.

PERSEA GRATISSIMA Gaertn.
Lenzites repanda Pers., on decaying branches.
Schizophyllum commune Fr., on dead branches.

PITHECOLOBIUM sp.
Lenzites repanda Pers., on dead wood.
Polystictus occidentalis Kl., on dead wood.

POLYALTHIA sp.
Corticium sp., on dead wood.
Cyathus plicatulus Poep., on dead wood.
Polyporus zonalis Berk., on dead wood.

POLYSCIAS NODOSA (Blume) Seem.
Pleurotus sp., on dead stem.

POMETIA PINNATA Forst.
Polystictus cryptomeniae P. Henn., on dead wood.

PROSOPIS VIDALIANA Naves.
Auricularia brasiliensis Fr., on dead branches.
Lenzites repanda Pers., on dead branches.

PSIDIUM GUAJAVA Linn.
Auricularia cornea Ehrenb., on dead wood.
Polystictus xanthopus Fr., on decaying branches.

PTEROCARPUS sp.
Polyporus zonalis Berk., on dead branches.
Polystictus sanguineus Linn., on old board.

PTEROCARPUS ECHINATUS Pers.
Auricularia cornea Ehrenb., on dead branches.

PTEROCARPUS INDICUS Willd.
Auricularia auricula-judae (Linn.) Schroet., on dead branches.
Lenzites striata Swartz, on painted board.
Schizophyllum commune Fr., on railway ties.
Trametes persoonii Mont., on dead log.

PTEROCYMBIUM TINCTORIUM (Blanco) Merr.
Lentinus strigosus Schw., on dead wood.

QUERCUS sp.
Hymenochaete rosea Lloyd, on dead wood.
Stereum spectabile Kl., on dead wood.

RAPANEA PHILIPPINENSIS (A. DC.) Mey.
Hexagona tenuis Hooker, on dead branches.

RUBIACEAE.
Polyporus perversus Copel., on dead stem.
Polyporus zonalis Berk., on dead stem.

SANDORICUM KOETJAPE (Burm. f.) Merr.
Fomes gibbosus Nees, on dead stump.

SAPINDUS SAPONARIA Blanco.
Auricularia cornea Ehrenb., on dead twigs.

SAPIUM MERRILLIANUM Pax et K. Hoffm.
Guepinia fissa Berk., on dead wood.
Stereum felloi Lloyd, on dead wood.

SHOREA sp.
Fomes applanatus Pers., on decaying wood.
Polystictus xanthopus Fr., on dead wood.
Poria sp., on dead wood.
Poria espimiltina Berk., on dead wood.

SHOREA GUISO (Blanco) Blume.
Corticium sp., on dead wood.
Polyporus rigidus Lév., on dead wood.
Polystictus versatilis Berk., on railway ties.
Tremella fuciformis Berk., on dead wood.

SHOREA MINDANENSIS Desp.
Schizophyllum commune Fr., on piling.

SHOREA PHILIPPINENSIS Brandis.
Polystictus sanguineus Linn., on piling.

SOLANUM GRANDIFLORUM Ruiz et Pav.
Auricularia cornea Ehrenb., on dead twigs.

SOLANUM VERBASCIFOLIUM Linn.
Auricularia cornea Ehrenb., on dead wood.

SPONDIAS LUTEA Linn.
Schizophyllum commune Fr., on dead branches.

STREBLUS ASPER Lour.
Auricularia auricula-judae (Linn.) Schroet., on dead wood.
Auricularia cornea Ehrenb., on dead wood.

STROMBOSIA PHILIPPINENSIS Rolfe.
Lenzites striata Swartz, on railway ties.

STRYCHNOS NUX-VOMICA Linn.
Auricularia auricula-judae (Linn.) Schroet., on dead branches.

TABERNAEMONTANA PANDACAQUI Poir.
Polyporus tabacinus Mont., on dead branches.

TAMARINDUS INDICA Linn.
Fomes applanatus Pers., on dead wood.
Lenzites repanda Pers., on dead branches.
Polystictus flavus Jungh., on dead log.
Polystictus occidentalis Kl., on dead wood.

TECOMA STANS (Linn.) Juss.
Auricularia cornea Ehrenb., on dead branches.

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TERMINALIA COMINTANA (Blanco) Merr.
Daedalea flavida Lév., on old board.
Polystictus versatilis Berk., on railway ties.

THEOBROMA CACAO Linn.
Auricularia cornea Ehrenb., on dead branches.
Trametes persoonii Mont., on dead branches.

TREMA AMBOINENSIS (Willd.) Blume.
Auricularia cornea Ehrenb., on dead wood.

TRIUMFETTA BARTRAMIA Linn.
Auricularia auricula-judae (Linn.) Schroet., on dead branches.

URENA LOBATA Linn.
Auricularia cornea Ehrenb., on dead branches.

VATICA sp.
Polystictus versatilis Berk., on railway ties.

VITEX sp.
Polyporus rigidus Lév., on dead branches.
Polystictus flavus Jungh., on dead branches.
Polystictus meyenii Kl., on dead wood.

VITEX PARVIFLORA Juss.
Guepinia fissa Berk., on railway ties.

VOACANGA GLOBOSA (Blanco) Merr.
Auricularia cornea Ehrenb., on dead branches.

ZEA MAYS Linn.
Lenzites acuta Berk., on dried ears.

ZIZYPHUS sp.
Phlebia reflexa Berk., on dead wood.
Polyporus mastoporus Lév., on dead wood.

THE PERMEABILITY OF CITRUS LEAVES TO WATER

By F. T. McLean

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ONE TEXT FIGURE

The resistance of leaves to injection has been little investigated. In most of the physiological studies thus far reported, leaves have been treated mainly as instruments for gaseous interchange with the air and for photochemical reactions. A few ecological studies have been made of the relation of the form of leaves to the removal of water, and the opinion has been expressed that certain structures are beneficial in preventing the clogging of the stomata with water and the flooding of the leaf tissues. So far as the writer is aware, there have been no studies of the pressures required to cause flooding. The resistance of leaves to the penetration of water may be important not only to prevent waterlogging of the tissues but also to prevent the entrance of certain leaf-disease organisms. Thus *Pseudomonas citri* Hasse, the cause of citrus canker, may be dependent mainly for its spread upon the permeability of the citrus leaves to water, as is suggested by McLean.[1] He found that the differences in the structure of the stomata of a disease-resistant mandarin orange variety and a susceptible grapefruit were of such a character that water could enter the stomata of the former more easily than those of the latter. The structure and behavior of the canker bacteria are such that infection most probably takes place by means of continuous water columns, either through the stomata or through wounds. Whether infection will take place in this manner through the stomata or not depends upon the amount of pressure necessary to force water through the stomata. There appears to be need for more data on this particular point.

There has been little study of the infiltration of the leaves of terrestrial plants with water, except in the case of a few epiphytic plants with special absorbing structures on the leaves. The infiltration of leaves with other liquids having a lower

[1] McLean, Forman T., A study of the structure of the stomata of two species of Citrus in relation to citrus canker, Bull. Torr. Bot. Club 48 (1921) 101–106.

surface tension than water, such as alchohol, benzol, etc., was employed by Molisch [2] as an index of the openness of the stomata. He studied the rate of infiltration of these liquids without employing pressure, and found that water was unsuitable for his purpose.

The study here reported was undertaken to ascertain what pressures are necessary to cause infiltration of water through the stomata of Citrus leaves. A satisfactory method of causing water to enter the leaves through the stomata and of observing the place and manner of entrance was devised and is here described. It was also found that penetration of water through the stomata can be easily induced under certain conditions, and that there are apparently differences in the amount of pressure required to cause penetration into the leaves of different varieties. Three varieties of Citrus were used in these tests: Washington navel orange, Szinkom mandarin orange, and Pernambuco grapefruit.

APPARATUS

The equipment employed is shown in figure 1. It consists of a flat gas chamber *g c* of metal with a tube connection at each end. The bottom is of glass; the metal top has a circular aperture in it about 1.5 centimeters in diameter, over which the leaf *l* is placed. The gas chamber is mounted on the stage of a compound microscrope *m*, in position to examine the leaf surface under the low power (16-millimeter objective). The right-hand tube of the gas chamber is connected to a mercury pressure gauge *p*, which is fitted with a scale *s* and mirror *n* to facilitate the rapid reading of the height of the mercury column by the observer seated at the microscope. The left-hand tube of the gas chamber is attached to an aspirator *e*, arranged to draw air from the gas chamber, the rate being controlled by means of the valve *v*.

PROCEDURE

A piece of convenient size, usually about 3 centimeters in diameter, was cut from the leaf to be tested, and the upper epidermis and palisade tissues were shaved off with a sharp razor from a small area in the center about 2 millimeters in diameter. Then the cut outer edges of the leaf were coated with paraffin (melting point, 45° C.), and it was then sealed on to the aperture of the gas chamber with paraffin, the intact lower surface

[2] Molisch, H., Opening and closure of stomata as shown by the method of infiltration, Zeitschr. Bot. 4 (1912) 106–122.

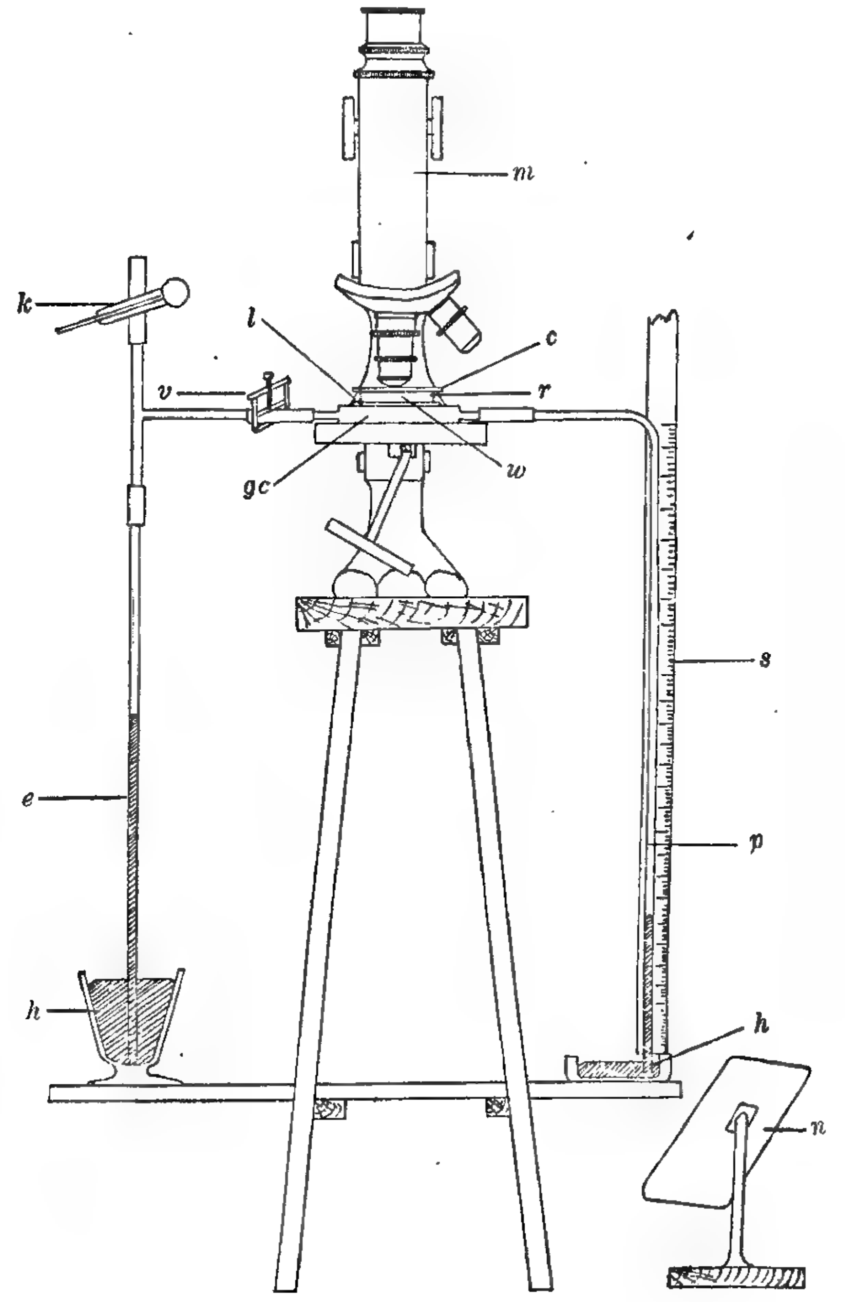

FIG. 1. Diagram of the apparatus used for measuring the pressures required to force water through the stomata of citrus leaves.

of the leaf uppermost and the shaved thin portion in the center of the aperture. A glass ring was then fastened over the leaf with paraffin, and the small reservoir formed by the leaf and the glass ring was filled with tap water and covered with a microscopic cover glass. The gas chamber was then connected with the pressure gauge and aspirator, and the leaf surface under water was examined with the low power of the microscope (16-millimeter objective) before any air was withdrawn from the gas chamber. In all cases the thinned portion of the leaf appeared opaque, due to the presence of air in the intercellular spaces, expect at the spots over oil glands, which were translucent. The stomata had their outer chambers filled with large air bubbles.

Air was then gradually withdrawn from the gas chamber under the leaf section by means of the aspirator. The partial vacuum in the chamber and consequent pull on the water tending to draw it into the leaf tissues were indicated by the height of the mercury in the pressure gauge. The condition of the leaf was closely watched meanwhile, until the appearance of new translucent spots indicated that the leaf tissues were flooded, or until drops of water were observed by their shadows to be forming on the thinned portion of the leaf. Then the height of the mercury in the pressure gauge was recorded, the water reservoir was removed from the leaf, and the portions where water penetration had occurred were carefully examined. Actual breaks in the epidermis were observed in only two cases, and both of these were due to rapid and excessive application of pressure to the leaf. These two tests were valueless and were therefore discarded. In most cases it was clear, from the slow rate of infiltration and from subsequent examination of the spot where the water had entered, that it had entered through the intact stomata. An effort was made to locate the particular stoma through which it first penetrated, but this could not be clearly distinguished because of the low magnification, and in several cases the penetration first occurred through the thick tissues at the edge of the thinned portion, where the stomata could not be clearly seen. While examining the flooded portions of the leaf, a few measurements of the width of the ridge of entrance of the larger stomata in this portion were made, because the width of the stomatal aperture is thought to be the controlling factor in preventing the entrance of water.

It was necessary to bring the leaves from the field to the laboratory for testing, and it was found that the preliminary treat-

ment of the leaves had a great effect upon the injection pressure observed. Therefore, several different treatments were tried, and the results of these are presented in Tables 1, 2, 3, and 4. All of these tables are arranged in the same manner. An arbitrary number is given to each test for convenience in designation. Pressure, causing penetration of water, was measured by means of the height, in centimeters, of the mercury column in the pressure tube. The averages of the width of the ridge of entrance of the stomata on the injected parts of the leaf are based on few measurements—usually ten and sometimes fewer—because the injected areas of the leaves were themselves small. The stomata varied considerably in size and only the larger ones were measured, as they were the ones through which the water would pass the most readily.

RESULTS

The earlier tests were made on leaves which had been kept in the comparatively dim light of the laboratory for varying lengths of time before testing. The results of these tests are assembled in Tables 1 and 2, those of Table 1 including those which had been in the laboratory for one-half day or less, and those of Table 2 for a longer time.

TABLE 1.—*Tests of the pressure required to inject water into freshly gathered Citrus leaves, detached from twigs and kept in water for a short time.*

Test No.	Date.	Hour.		Kind of leaf.	Pressure.	Width of ridge of entrance of stoma.	
						Maximum.	Average.
		a. m.	*p. m.*		*cm. Hg.*	*μ*	*μ*
1	April 3		4.00	Young Pernambuco grapefruit	6.5	8.8	7.8
2	April 3		4.30	Young Kishiu mandarin orange	11.5	4.0	2.0
3	April 3		4.50	Young Szinkom mandarin orange	23.0	3.8	3.0
4	April 4	9.00		Old Washington navel orange	15.0	9.0	7.8
5	April 4	9.00		Medium Washington navel orange	22.5	7.7	7.3
6	April 4	9.00		Young Washington navel orange	12.0	7.7	6.3
7	April 4	11.30		Half-grown Washington navel orange	10.3	6.0	4.8
8	April 5	10.45		Medium Pernambuco grapefruit	12.0	9.7	6.0
9	April 5		12.00	Young Pernambuco grapefruit	12.5	8.0	6.3

TABLE 2.—*Tests of pressure required to inject water into Citrus leaves, detached from twigs and kept with their petioles in water in the diffused light of the laboratory for one-half day longer.*

Test No.	Date.	Hour.		Kind of leaf.	Pressure.	Width of ridge of entrance of stoma.	
						Maximum.	Average.
		a. m.	p. m.		cm. Hg.	μ	μ
10	April 4		3.10	Medium Washington navel orange.	21.5	9.7	7.3
11	April 4		3.35	Half-grown Szinkom mandarin orange	31.5	3.0	2.6
12	April 4		4.10	Old, yellow Szinkom mandarin orange	31.0	6.3	4.0
13	April 4		4.50	Old Pernambuco grapefruit	6.0	10.0	9.0
14	April 4		5.25	Young Szinkom mandarin orange.	31.5		
15	April 5		3.45	Young Pernambuco grapefruit	25.6		
16	April 7	11.45		do	9.5		
17	April 5	4.50		do	14.0	7.2	4.7

A comparison of the leaves of different apparent ages of the three different varieties showed no clear relationship between age and injection pressure. The individual variations between tests were so great that, in order to eliminate one possible variant, subsequent tests were confined to comparatively young leaves. Therefore, no conclusion can be drawn from these observations concerning the effect of age of the leaves upon the injection pressure. All of the above tests show exceedingly variable and generally high injection pressures, probably due to the unfavorable conditions to which they were subjected in the laboratory.

Several tests were made on leaves which had been immersed in water and placed in the window in bright diffuse light previous to testing. The results of these are assembled in Table 3. Some of these were tested before placing them in the window, and are thus entered in Table 2. These repeated tests on the same leaves are particularly valuable for comparison and to show the effect of conditions of exposure on the leaf properties.

The injection pressures shown in Table 3, in which the leaves were immersed in water and kept in bright light before testing, are generally lower than those in Tables 1 and 2. Thus the values in Table 3 range from 2 and 5 millimeters in tests 23 and 29 for Pernambuco grapefruit, to 15.5 and 18.0 centimeters in tests 27 and 28 for Szinkom mandarin. Further, a comparison of the same leaf, tested in each of the two series, is illuminat-

TABLE 3.—*Tests of pressure required to inject water into Citrus leaves, detached from the plant, immersed in water, and placed in bright light in the laboratory window.*

Test No.	Date.	Hour.	Kind of leaf.	Pressure.	Width of ridge of entrance of stoma. Maximum.	Width of ridge of entrance of stoma. Average.
		p. m.		*cm. Hg.*	*μ*	*μ*
18	April 5	2.80	Medium Pernambuco grapefruit	9.5		
19	April 5	3.40	do	2.0	7.5	6.2
20	April 5	4.00	Young Pernambuco grapefruit	5.5	9.7	7.0
21	April 6	2.00	Medium Pernambuco grapefruit	3.0	10.0	7.9
22	April 6	2.40	Young Szinkom mandarin orange	5.0	6.0	4.8
23	April 6	3.45	Young Pernambuco grapefruit	0.2		
24	April 6	4.07	do	5.5	9.3	7.7
25	April 6	4.42	Young Szinkom mandarin orange	12.5	6.7	3.5
26	April 7	3.10	do	1.6	7.3	5.6
27	April 7	3.40	do	15.5		
28	April 7	4.20	do	18.0	5.7	4.3
29	April 7	4.30	Young Pernambuco grapefruit	0.5	9.3	8.7

ing. Thus a medium Pernambuco grapefruit leaf in the first series (No. 8, Table 1) gave an injection pressure of 12.0 centimeters, while the same leaf, under the more favorable treatment in the second series (Nos. 18, 19, and 21, Table 3), gave values of 9.5, 2.0, and 3.0 centimeters successively. The lowest pressures obtained in this series, as shown in Table 3 for Pernambuco, are of such magnitude as might easily occur in leaves on the trees, due to changes of temperature when the leaves are wet, or even to rapid expansions and contractions of the air chambers when the leaves are bent in being blown about by the wind. The combination of abundant moisture and light provided in these tests appears to have caused the stomata to open and make the entrance of water easy.

The tests in Tables 1, 2, and 3 do not nearly approach the normal conditions to which the leaves on the trees are subjected during bright sunny weather. Therefore, a third lot of leaves were left attached to twigs, which were put in water and placed so as to be fully exposed to the sun. These were tested at intervals during the day, and the results are tabulated in Table 4.

The young leaves on twigs and exposed to full insolation show great variations in the pressures required to inject them with water. Using similar Szinkom leaves for all tests, the values varied from 5.5 to more than 38.0 centimeters. Since these

leaves were fully exposed to sunlight, these differences may have been caused by variations in the rates of transpiration.

TABLE 4.—*Tests of pressure required to inject water into Citrus leaves, attached to twigs and standing in water, fully exposed to the sun before testing them.*

Test No.	Date.	Hour.		Kind of leaf.	Pressure.	Width of ridge of entrance of stoma.	
						Maximum.	Average.
		a. m.	p. m.		cm. Hg.	μ	μ
30	April 7	8.26		Young Szinkom mandarin orange.	5.5	6.0	4.3
31	April 7	10.35		do	20.5		
32	April 7	11.25		do	29.5	4.7	4.2
33	April 7		2.15	do	7.5		
34	April 7		2.40	do	17.0	7.0	4.1
35	April 7		4.10	do	38.0+		

With the small number of data presented, and these of such a highly variable character, it is obviously unsafe to make any more than the most general sort of conclusions. The effects of the different treatments employed appear to be quite evident from the foregoing comparisons of results. Less satisfactory conclusions can be reached regarding the differences between the different varieties, and the possible correlation between the width of the ridge of entrance of the stoma and the injection pressure. Certain generalities are allowable from the data shown. Thus a consideration of the lowest values obtained, as shown in Table 3, indicates that Pernambuco grapefruit is usually more easily injected than Szinkom mandarin, since of the five injection pressures below 5 centimeters four, including the two lowest values (2 and 5 millimeters), are for Pernambuco and only one (1.6 millimeters) is for Szinkom. Further, the average injection pressure for Pernambuco is 7.9 centimeters, while for Szinkom (taken from the first three tables only, for those in Table 4 are not considered to be at all comparable to the others) it is 18.3 centimeters. Likewise, the average width of the ridge of entrance of the stomata of Pernambuco is 7.0 μ and of Szinkom, 4.1 μ. Thus the average values for the two varieties indicate that Pernambuco grapefruit is more easily injected and has wider stomatal apertures than Szinkom mandarin.

Another more extensive series of tests of the injection pressures of Citrus leaves is being made on leaves attached to the trees in the field, using a different technic. The results of these

will be the subject of a later contribution. The data thus far obtained on the leaves on the trees bear out in a general way the tentative conclusions stated above.

SUMMARY

1. A method is described for determining the pressure required to force water through the stomata of leaves.

2. The pressure required to inject leaves of the same variety seems to vary greatly in accordance with the treatment before testing, and seems to be lowest when the leaves are exposed to bright diffused light and well supplied with moisture.

3. Apparently Szinkom mandarin orange leaves require on the average more than twice as much pressure to inject them with water as is required for the leaves of Pernambuco grapefruit.

4. The conclusion stated in 3 seems to be correlated with the average width of the stomatal aperture through the epidermis, that of Szinkom mandarin orange being a little more than half as wide as that of Pernambuco grapefruit.

ILLUSTRATION

TEXT FIGURE

FIG. 1. Diagram of the apparatus used for measuring the pressures required to force water through the stomata of citrus leaves.

REVIEWS

Introduction | General Chemistry | an exposition of the principles of | modern Chemistry | by | H. Copaux | [two lines of titles] | translated by | Henry Leffmann, A.M., M.D. | [two lines of titles] | with 30 illustrations | Philadelphia | P. Blakiston's Son & Co. | 1012 Walnut Street | Cloth, pp. i–x + 1–195 including index. Copyright, 1920.

TRANSLATOR'S NOTE

Professor Copaux's work presents in compact, yet clear form a large amount of information on the principles of chemistry as recognized today by the leaders in the science. I have endeavored to render the text into standard English, and thus make it available to a wider group of readers, to whom it will be a valuable guide.

Those who, like myself, began the study of chemistry just after the middle of the last century, will find many points of difference between this book and the manuals of the early days, yet the fundamental features of the science remain unchanged. The atom is still the unit of chemical action, and the balance is still, as in the laboratory of Lavoisier, the chemist's main reliance.

While the translation was in progress, Professor Copaux kindly sent a copy of the book with notes of corrections of a few typographic errors, and some changes in phraseology adding to the explicitness or comprehensiveness of the text. These suggestions have been given attention.

French-English | Medical Dictionary | by | Alfred Gordon, A. M., M. D. (Paris) | [seven lines of titles] | Philadelphia | P. Blakiston's Son & Co. | 1012 Walnut Street | Cloth, $3.50 net, pp. 1–161. Copyright, 1921.

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FOREWORD

The information most eagerly sought by those entering upon the work among the feeble-minded is naturally how to easily recognize the various forms of mental defect, in order that they may define, and meet promptly, the special needs of those with whom they are brought in daily contact.

To this end, types of various grades are useful as sign-posts pointing the way to successful diagnosis of defect—mental, moral and physical. In defining types many points, such as have been indicated by tests, as well as by the stigmata of degeneration noted in the individual, are to be considered.

Appended herewith will be found the educational classification, which, as the outgrowth of a close study of cases and careful adaptation to needs—indorsed by both physicians and teachers—has proven in a long experience the best one as simplifying the tasks of all engaged in the work.

This classification is arrived at by first separating broadly the *untrainable idiot* from the *trainable imbecile* in asylum, custodial, and school division; next by dividing the imbeciles into grades of mentality for the awakening and further development of power along lines suited to the capacity of each; and finally by indicating possible training for life work in industrial or manual lines according to individual proclivity.

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